RCRA Facility Investigation – Remedial Investigation/ Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 5 of 15
Inter-Drainage
Exposure Unit

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
CNHP	Colorado Natural Heritage Program
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOC	ecological contaminant of concern
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency

EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
HQ	hazard quotient
HRR	Historical Release Report
IA	Industrial Area
IAEU	Industrial Area Exposure Unit
IAG	Interagency Agreement
IDEU	Inter-Drainage Exposure Unit
IHSS	Individual Hazardous Substance Site
kg	kilogram
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg BW/day	milligram per kilogram receptor body weight per day
mg/L	milligram per liter
mL	milliliter
mL/day	milliliter per day
N/A	not applicable or not available
NFA	No Further Action

NFAA	No Further Accelerated Action
NNEU	No Name Gulch Drainage Exposure Unit
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QA/QC	Quality Assurance/Quality Control
QAPjP	Quality Assurance Project Plan
RCEU	Rock Creek Drainage Exposure Unit
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	site conceptual model

tESL	threshold ESL
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UTL	upper tolerance limit
UWNEU	Upper Walnut Drainage Exposure Unit
UWOEU	Upper Woman Drainage Exposure Unit
VOC	volatile organic compound
WAEU	West Area Exposure Unit
WRS	Wilcoxon Rank Sum
WRV	wildlife refuge visitor
WRW	wildlife refuge worker
WSF	West Spray Field

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 596-acre Inter-Drainage Exposure Unit (EU) (IDEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of the Comprehensive Risk Assessment (CRA) is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at RFETS after completion of accelerated actions.

No COCs were selected in surface soil/surface sediment and subsurface soil/subsurface sediment during completion of the HHRA COC selection process. Only one analyte, arsenic, had concentrations in IDEU surface soil/surface sediment that were statistically greater than RFETS background. However, arsenic was subsequently eliminated as a COC in the professional judgment evaluation of the COC selection process because the weight of evidence supports the conclusion that concentrations of arsenic in the IDEU are not the result of RFETS activities, but rather are representative of naturally occurring concentrations. For comparative purposes, cancer risks and noncancer hazard quotients (HQs) were estimated for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) for arsenic in IDEU surface soil/surface sediment and in RFETS background surface soil/surface sediment. The estimated cancer risks for the WRW and WRV associated with potential exposure to arsenic in surface soil/surface sediment in the IDEU are both approximately 3E-06. The estimated noncancer HQs associated with potential exposure to arsenic in surface soil/surface sediment in the IDEU are approximately 0.02 for the WRW and 0.01 for the WRV. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of arsenic in RFETS surface soil/surface sediment are 2E-06 and 1E-06, respectively. The estimated HQs associated with potential exposure to background levels of arsenic in RFETS surface soil/surface sediment are approximately 0.01 for the WRW and 0.007 for the WRV. No analytes in subsurface soil/subsurface sediment were statistically greater than RFETS background. These results indicate that potential health risks for the WRW and WRV in the IDEU are expected to be similar to background risks, and there are no significant human health risks from RFETS-related operations at the IDEU.

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the IDEU. The ECOPC identification process is described in the CRA Methodology (U.S. Department of Energy [DOE] 2005a) and additional details are provided in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. Only two ECOIs in surface soil (antimony and lead) were identified as ECOPCs for representative populations of non-Preble's meadow jumping mouse (PMJM) receptors. No ECOPCs were identified for individual PMJM receptors in surface soil. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology (DOE 2005a).

Tier 1 and Tier 2 exposure point concentrations (EPCs) were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were considered to provide a refined estimate of potential risk.

Using Tier 1 EPCs and the default exposure and risk assumptions, no observed adverse effect level (NOAEL) HQs ranged from 1 (lead/mourning dove-herbivore) to 4 (antimony/deer mouse-insectivore and lead/mourning dove-insectivore). Using Tier 2 EPCs, NOAEL HQs ranged from 1 (lead/mourning dove-herbivore) to 11 (antimony/deer mouse-insectivore).

Using Tier 1 and Tier 2 EPCs, two of three ECOPC/receptor pairs had lowest observed adverse effect level (LOAEL) HQs less than or equal to 1 using the default assumptions used in the risk calculations. However, the lead/mourning dove-insectivore receptor pair had LOAEL HQs greater than 1 using the default risk model:

- Lead/mourning dove (insectivore) – LOAEL HQs were equal to 3 using Tier 1 and Tier 2 EPCs. No median BAFs or additional TRVs were available for a refined risk analysis. Therefore, potential adverse effects to mourning dove (insectivore) populations are likely to be low to moderate. However, the LOAEL HQ based on the default ESL and the background UTL is the same as the LOAEL HQ based on the default ESL and IDEU UTL (HQs = 3). Therefore, risks from exposure to lead in soil in the IDEU are essentially the same as risks in background areas.

Based on the default calculations, site-related risks are likely to be low to moderate for the ecological receptors evaluated in the IDEU. For the one ECOPC/receptor pair with a LOAEL HQ greater than one (lead/mourning dove [insectivore]), risks in the IDEU are essentially the same as risks in background areas. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data and, therefore, no ecological contaminants of concern (ECOCs) for the IDEU.

1.0 INTER-DRAINAGE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Inter-Drainage Exposure Unit (EU) (IDEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. The HHRA and ERA methods and selection of receptors are described in detail in the approved CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report).

The anticipated future land use of RFETS is a wildlife refuge. Two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS.

1.1 Inter-Drainage Exposure Unit Description

This section provides a brief description of the IDEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report. This information is also summarized in Appendix A, Volume 2 of the RI/FS Report.

The 2005 Annual update to the Historical Release Report (HRR) (DOE 2005b) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR (DOE 1992a) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) areas (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG 1991) and the 1996 Rocky Flats Cleanup Agreement (RFCA 1996), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, while Table 1.4 of the RI/FS Report summarizes the disposition of all historic IHSSs at RFETS. In the 2005 Annual Update to the HRR (DOE 2005b) each historical IHSS is provided a description of the potential contaminant releases and any interim response to the releases; identifications of potential contaminants based on process knowledge, and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

Two former IHSSs and two former PACs exist within the IDEU (Figure 1.2): the West Spray Field (WSF) (IHSS 168), the Nickel Carbonyl Disposal Area (IHSS 195), roadway spray areas (PAC-000-501), and the tear gas powder release (PAC NE-1400). These documented historical source areas are described in Table 1.1. IHSS 168 was also designated as OU 11. OU 11 was dispositioned through a no further action (NFA) CAD/ROD, approved in October 1995 (Administrative Record reference OU11-A-000184) (DOE 1995b). A Risk Evaluation performed for the Final "No Further Action Justification" document (DOE 1992b) determined that IHSS 195 presented no unacceptable risk to groundwater or human health and the environment. IHSS 195 was dispositioned in the August 1994 CAD/ROD for OU 16, Low Priority Sites. The PACs were two of 79 IHSSs/PACs proposed for No Further Action (NFA) by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA and CDPHE 2002) and is documented in the 2002 HRR Update (DOE 2002). In general, NFAs and NFAAs are based on human health exposures. The intent of the ecological component of the CRA is to evaluate any potential risk to ecological receptors associated with the residual contamination at the site following the accelerated actions.

1.1.1 Exposure Unit Characteristics and Location

The 596-acre IDEU is located in the northwestern portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The IDEU is located within the Buffer Zone (BZ) OU and is outside the Industrial Area (IA) that was used historically for manufacturing and processing operations at RFETS;

- The IDEU is located generally upwind and hydraulically upgradient of the IA; and

- The IDEU is a functionally distinct exposure area. It is a level terrace of the Rocky Flats plain, lying between two stream-cut valleys (Rock Creek and Walnut Creek), with sparse vegetation and a relative scarcity of water and wetland habitat.

The IDEU is bounded by the West Area EU (WAEU) to the west; the Rock Creek Drainage EU (RCEU) to the northwest; and the No Name Gulch Drainage EU (NNEU), Upper Walnut Drainage EU (UWNEU), and Industrial Area EU (IAEU) to the southeast

(Figure 1.1). Acreage south of the IDEU consists of the Upper Woman Drainage EU (UWOEU) and privately owned land.

1.1.2 Topography and Surface Water Hydrology

The IDEU gently slopes from the southwest to the northeast, straddling the Rock Creek and Walnut Creek drainage basins. The IDEU includes the main portions of Upper Church Ditch and McKay Ditch, as well as portions of the McKay Bypass Canal (Figure 1.2).

Upper Church Ditch is a seldom used, although still active, water conveyance structure that diverts water from Coal Creek to Upper Church Lake and the Great Western Reservoir. The City of Broomfield owns and operates this ditch. Upper Church Ditch runs along the length of the IDEU and parallels McKay Ditch on the upslope side.

McKay Ditch diverts water for irrigation from the South Boulder Diversion Canal to the Great Western Reservoir. The City of Broomfield owns and operates this ditch. McKay Ditch is generally dry, except in the spring. Originally, McKay Ditch flowed into North Walnut Creek. In September 1974, the West Diversion Ditch and McKay Bypass Canal were constructed to route McKay Ditch flow north of the Present Landfill. Water in the upper reaches of the North Walnut Creek watershed (west of the IA) is intercepted and diverted by the West Diversion Ditch, which also discharges into the McKay Bypass Canal. The McKay Bypass Canal runs eastward paralleling Upper Church Ditch and McKay Ditch for about 8,000 feet.

A small man-made pond is located in the southern portion of the IDEU. The pond has been used for raw water storage prior to treatment and distribution for drinking water at RFETS. The pond is referred to as the Raw Water Pond, or 124 Pond, because it was connected by a pipeline to the drinking water treatment plant (Building 124). A water source no longer exists for the pond, and it is anticipated that it will become dry.

Two prominent surface disturbance features and a pond are visible on an October 2004 aerial photograph (Figure 1.3). The disturbed area located in the southwestern portion of the IDEU is associated with gravel-mining activities. The second area in the central portion of the IDEU was excavated to accommodate a landfill, but was never used as a landfill (that is, no waste disposal activities took place). It is currently used as a staging area for site activities.

1.1.3 Flora and Fauna

The IDEU is characterized predominantly by xeric tallgrass prairie (Figure 1.4). Small areas of wetland and mesic mixed grassland exist in and adjacent to the drainages. An area of xeric needle and thread grass prairie exists in the northern portion of the IDEU. The xeric tallgrass prairie is distinguished at RFETS by such plant species as big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), Indian-grass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*), the same species that dominate the plant community on the eastern edge of the Great Plains.

Land that is within the IDEU was heavily grazed during the past land use. With the purchase by the DOE, grazing has not occurred in decades within the EU, and plant communities have nearly returned to pre-grazing conditions. No federally listed plant species are known to occur at RFETS. However, the xeric tallgrass prairie, tall upland shrubland, riparian shrubland, and plains cottonwood riparian woodland communities are considered rare and sensitive plant communities by the Colorado Natural Heritage Program (CNHP). In particular, portions of the xeric tallgrass prairie plant community are found within the IDEU and along with other areas within RFETS and the surrounding lands, comprise one of the largest remnants of xeric tallgrass prairie.

RFETS also supports populations of four rare plant species that are listed as rare or imperiled by the CNHP. These include: forktip three-awn (*Aristida basiramea*), mountain-loving sedge (*Carex oreocharis*), carrionflower greenbriar (*Smilax herbacea var. lasioneuron*), and dwarf wild indigo (*Amorpha nana*). The IDEU contains two of these rare plant species, the mountain-loving sedge and the forktip three-awn (K-H 2002b). The mountain-loving sedge grows in dry grasslands and prefers locations off the edge of the pediment on north-facing slopes. This plant occurs along the northwestern edge of the IDEU. Forktip three-awn occurs within the xeric tallgrass prairie in areas that have been disturbed and the vegetation has been removed. There are few locations where forktip three-awn are known to exist in Colorado and RFETS has several sites (K-H 2002b).

Numerous animal species have been observed at RFETS, and the more common ones are expected to be present in the IDEU. Common large- and medium-sized mammals likely to live at or frequent the IDEU include deer (*Odocoileus hemionus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), desert cottontail (*Sylvilagus audubonii*), and white-tailed jackrabbit (*Lepus townsendii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*), and the most common birds include meadowlark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*) and mourning dove (*Zenaida macroura*). The most common small mammal species include deer mouse (*Peromyscus maniculatus*) and prairie vole (*Microtus ochrogaster*). Xeric grasslands also support two different species of pocket mouse (*Perognathus sp*.) (DOE 1995a).

RFETS supports two wildlife species listed as threatened or endangered species under the Endangered Species Act (USFWS 2005). The Preble's meadow jumping mouse (PMJM; *Zapus hudsonius preblei*) and the bald eagle (*Haliaeetus leucocephalus*) are listed as threatened species. The PMJM occurs in every major drainage at RFETS including IDEU. The bald eagle occasionally forages at RFETS although no nests have been identified on site.

There are also a number of wildlife species that have been observed at RFETS that are species of concern by the State of Colorado (USFWS 2005). The plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) is listed as endangered by the State and has been observed infrequently at RFETS. The western burrowing owl (*Athene cunicularia hypugea*) is listed as threatened by the State and is a known resident or regular visitor at RFETS. The ferruginous hawk (*Buteo regalis*), American peregrine falcon (*Falco*

peregrinus), and the northern leopard frog (*Rana pipiens*) are listed as species of special concern by the State and are considered known residents or regular visitors at RFETS. The following species are listed as species of special concern and are observed infrequently at RFETS: greater sandhill crane (*Grus canadensis tibida*), long-billed curlew (*Numenius americanus*), mountain plover (*Charadrius montanus*), and the common garter snake (*Thamnophis sirtalis*).

More information on the species that use the habitats at RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat within Inter-Drainage Exposure Unit

IDEU supports habitat for the federally protected PMJM. The preferred habitat for the PMJM is the riparian corridors bordering RFETS' streams, ponds, and wetlands with an adjacent thin band of upland grasslands. PMJM habitat occurs along the upper reach of North Walnut Creek in the southwestern portion of the IDEU and along the northwest edge of the EU bordering the Rock Creek drainage EU (RCEU) (Figure 1.5). The lack of continuously running water along McKay Ditch is likely a limiting factor to PMJM abundance.

In an effort to characterize habitat discontinuity and provide indications of varying habitat quality, sitewide PMJM habitat patches were developed. Figure 1.5 presents PMJM patches within the IDEU. Patches that cross over into adjacent EUs are either evaluated in the adjacent EU (Patch #5 in the RCEU) or are considered a part of IDEU (Patch #9) as described below. PMJM patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual PMJM or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

After recognizing patches that cross over into other EUs, only two PMJM habitat patches within the IDEU were evaluated in this volume. The following is a brief discussion of the two patches within the IDEU (Figure 1.5):

- Patch #9 – This patch contains short marsh and small areas of riparian shrublands intermixed with snowberry, which is an upland shrub. This patch is mapped as protected habitat (USFWS 2004) due to the presence of woody riparian vegetation along the upper reaches of North Walnut Creek (Figure 1.4). This area contains the vegetative components necessary for PMJM habitat, but typically lacks water. The patch only receives water during storm events and when the ditch is conveying water. The habitat quality of this patch is very low and no PMJM have ever been observed in or near this area on RFETS.

- Patch #31 – This patch begins along the border with the West Area EU and continues east along McKay Ditch to the confluence with the McKay Ditch Bypass Canal. This patch is mapped as protected habitat (USFWS 2004) due to the presence of riparian woodlands along McKay Ditch (Figure 1.4). This area

contains the vegetative components necessary for PMJM habitat, but typically lacks water. The patch only receives water during storm events and when the ditch is conveying water. The habitat quality of this patch is very low and no PMJM have ever been observed in or near this area on RFETS.

1.1.5 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the IDEU. The data set for the CRA was prepared in accordance with data processing steps described in Appendix A, Volume 2, Attachment 2 of the RI/FS Report. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical Quality Assurance/Quality Control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the IDEU is provided on a compact disc (CD) presented in Attachment 6. The CD includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the IDEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

The data for these media are briefly described below.

In addition, because ECOPCs were identified for soil in this EU, surface water data were used in the ERA as part of the overall intake of ecological contaminants of potential concern (ECOPCs) by ecological receptor. The surface water data used in the ERA are summarized in Table 8.5. Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15B of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the IDEU consists of up to 83 samples that were analyzed for inorganics (64 samples), organics (three samples), and radionuclides (83 samples) (Table 1.2). The data include sediment samples collected to depths down to 0.5 feet bgs. The sampling locations for surface soil and surface sediment are shown on Figure 1.6. All sample locations within the IDEU were not necessarily analyzed for all analyte groups (see Table 1.3). Surface soil/surface sediment samples were collected in the IDEU for several months from November 1992 through September 1994, and then again in February 2004 and March 2004. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one from the center, as described in the Addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the IDEU is presented in Table 1.3. Detected analytes include representatives from the inorganics and radionuclides analyte groups. A summary of analytes that were either not detected in, or detected in less than 5 percent of, surface soil/surface sediment samples, in the IDEU is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. Subsurface sediment samples (sediment samples with a start depth less than or equal to 8 feet bgs and an end depth below 0.5 feet) were not collected in the IDEU. The combined subsurface soil/subsurface sediment data set for the IDEU consists of up to 72 samples that were analyzed for inorganics (72 samples), organics (65 samples), and radionuclides (70 samples) (Table 1.2). The sampling locations for subsurface soil are shown in Figure 1.7. All sample locations within the IDEU were not necessarily analyzed for all analyte groups (see Table 1.4). Subsurface soil samples were collected in the IDEU for several months from February 1992 through August 1994, and then again in February 2004.

The data summary for detected analytes in subsurface soil/subsurface sediment for the IDEU is presented in Table 1.4. Detected analytes include representatives from the

inorganics, organics, and radionuclides analyte groups. A summary of analytes that were either not detected in, or detected in less than 5 percent of, subsurface soil/subsurface sediment samples in the IDEU is presented and discussed in Attachment 1.

Surface Soil

Data meeting the CRA requirements are available for up to 81 surface soil samples collected in the IDEU that were analyzed for inorganics (64 samples), organics (three samples), and radionuclides (81 samples) (Table 1.2). The surface soil sampling locations for the IDEU are shown in Figure 1.6. All sample locations within the IDEU were not necessarily analyzed for all analyte groups (see Tables 1.5 and 1.6). Surface soil samples were collected in the IDEU for several months from November 1992 through September 1994, and then again in February 2004 and March 2004. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one from the center, as described in the Addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in IDEU surface soil is presented in Table 1.5, while the data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. There is only one sample location within PMJM habitat in the IDEU and this sample was analyzed for radionuclides only (see Table 1.2). However, as discussed in Appendix A, Volume 2 of the RI/FS Report, three samples within 100 feet of PMJM habitat Patch #31 were also used in the PMJM data set for the IDEU (see Figure 1.5). In addition, Patch #9 was also included as a part of the PMJM habitat for IDEU even though half of this patch is located within the UWNEU. Four additional sample locations within 100 feet of Patch #9 (but within UWNEU) were also included in the PMJM dataset for IDEU (see Figure 1.5). Four out of the eight samples were analyzed for radionuclides and seven out of the eight samples were analyzed for inorganics (see Table 1.6). No samples were analyzed for organics. A summary of analytes that were either not detected in, or detected in less than 5 percent of, surface soil samples in the IDEU is presented and discussed in Attachment 1.

Subsurface Soil

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The subsurface soil data set for the IDEU consists of up to 72 samples that were analyzed for organics (65 samples), inorganics (72 samples), and radionuclides (70 samples) (Table 1.2). Subsurface soil sampling locations are shown in Figure 1.7. All sample locations within the IDEU were not necessarily analyzed for all analyte groups (see Table 1.7). Subsurface soil samples were collected in the IDEU for several months from February 1992 through August 1994, and then again in February 2004.

The data summary for detected analytes in subsurface soil for the IDEU is presented in Table 1.7. Subsurface soil samples were analyzed for inorganics, organics, and

radionuclides, and representatives from all three analyte groups were detected. A summary of analytes that were either not detected in, or detected in less than 5 percent of, subsurface soil samples in the IDEU is presented and discussed in Attachment 1.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2, Attachment 3 of the RI/FS Report. The adequacy of the data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. If the data do not meet the guidelines, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) are examined to determine if it is possible to make risk management decisions given the data limitations.

The findings from the data adequacy assessment applicable to all EUs are as follows:

- The radionuclide and inorganic surface soil data are adequate for the purposes of the CRA.

- For herbicides and pesticides, although the existing surface soil and sediment data may not meet the minimal data adequacy guidelines for each EU, there is considerable site-wide data, and pesticides and herbicides are infrequently detected at low concentrations, generally below PRGs and ESLs. This line of evidence indicates that it is possible to make risk management decisions without additional sampling for these analyte groups

- For dioxins, although the existing surface soil and sediment data do not meet the minimal data adequacy guidelines for each EU, sample locations were specifically targeted for dioxin analysis at historical IHSSs in and near the former Industrial Area where dioxins may have been released based on process knowledge. Some of the dioxin concentrations at the historical IHSSs exceed the PRG and/or ESL. Additional samples were collected in targeted locations that represented low-lying or depositional areas where dioxin contamination may have migrated via runoff from these specific IHSSs. Results indicate that dioxin concentrations are not above the minimum ESL in sediment and dioxins are not detected in surface water. Therefore, although the existing data do not meet the minimal data adequacy guidelines for each EU/AEU, it is possible to make risk management decisions without additional sampling. However, unlike pesticides and herbicides where there is considerably more site-wide data, there is greater uncertainty in the overall risk estimates because fewer samples were collected at the site for dioxins.

- Subsurface soil contamination is largely confined to historical IHSSs (that is, areas of known or suspected historical releases). These areas have been

characterized to understand the nature and extent of potential releases. For historical IHSSs where subsurface soil samples were not collected for an analyte group, the presence of this type of subsurface contamination was not expected based on process knowledge. Therefore, the existing subsurface soil data are adequate for the purposes of the CRA.

The findings from the data adequacy report applicable to the IDEU are as follows:

- For surface soil and surface soil/surface sediment, data for at least 5 samples does not exist for the organic analyte groups; there are 3 samples for VOCs and SVOCs and no samples for PCBs. The VOC and SVOC data for the 3 surface soil samples indicate non-detectable concentrations of these analytes. With the exception of PAC 000-501 (Roadway Spray Areas), historical IHSSs in the IDEU are not expected to be historical sources of organic contamination, PAC 000-501 are roads that were sprayed with waste oil for dust control, and accordingly, the oil could have contained polynuclear aromatic hydrocarbons (PAHs) but not PCBs.[1] However, 2 of the 3 samples collected for SVOC analysis are near the road, and PAHs (naphthalene was the only PAH analyzed) were not detected. Also, data for samples collected near PAC 000-501 in the Upper Woman Drainage EU and the Lower Woman Drainage EU, indicate that PAHs (and PCBs) are not detected, and the entire suite of PAHs was analyzed at these locations. Furthermore, the IDEU is hydraulically upgradient and generally upwind of potential historical source areas in and near the IA. Therefore, although the existing organics data do not meet the minimal data adequacy guidelines for the EU, available information on potential historical sources of contamination in the EU, contaminant migration pathways from potential sources in other EUs, and concentration levels in surface soil show that organic constituents are not likely to be present in surface soil or sediment for this EU, and it is possible to make risk management decisions without additional sampling.

- No surface soil or sediment samples were collected for dioxins in the IDEU. Although this does not meet the minimal data adequacy guideline, as noted above, dioxins are not expected to have been released in IDEU and it is possible to make risk management decisions without additional sampling.

- With the exception of VOCs and SVOCs, surface soil sample locations meet the data adequacy guideline for spatial representativeness. Surface soil sample locations for the VOCs and SVOCs are clustered in the central portion of the EU. However, because VOCs and SVOCs are not expected to be present in surface soil in the IDEU, it is possible to make risk management decisions without additional sampling.

[1] Based on the summary presented for PAC 000-501 in the 2005 Annual Update to the Historical Release Report (DOE 2005a), the sources of oil for roadway spraying in the Inter Drainage EU, Upper Woman Drainage EU, and Lower Woman Drainage EU would be one or both of the following: in October 1982, 120 liters of Number 2 diesel fuel from a tank spill on the northern side of Building 371 was used on roads; and in September 1983, 1,200 gallons of Mobil Number 634 gear lubrication oil from a Building 883 rolling mill lube system was used on Plant gravel roads. These oils are not expected to contain PCBs.

- Because only one sample was collected in PMJM habitat patches #9 and #31, in accordance with the data adequacy guideline, data from seven additional samples within approximately 100 feet of the patches was used to complement the data set. Inclusion of these samples provides additional radionuclides and metals data for the PMJM risk characterization, but organic data is absent. However, as discussed above, organics are not expected to be present in surface soil in this EU. Therefore, although the existing organics data do not meet the minimal data adequacy guidelines for the EU PMJM patches, it is possible to make risk management decisions without additional sampling.

- There are data for at least 5 surface water samples for radionuclides, metals and VOCs. Therefore, the data for these analyte groups are considered adequate for the purposes of the CRA. There are no data for SVOCs, PCBs, and dioxins; however, as noted above, these organics are not expected to be present in surface soil or surface water in this EU. Therefore, it is possible to make risk management decisions without additional sampling.

- There are no surface water data from 2001 to the present for any of the analyte groups. However, the closest IHSS to McKay Ditch is the West Spray Field (IHSS 168). Runoff from this IHSS is to the east and would thus not impact McKay Ditch. Therefore, although the data do not meet the data adequacy guideline for temporal representativeness, available information on potential historical sources of contamination and migration pathways indicate concentration trends for the constituents in these analyte groups are unlikely, and it is possible to make risk management decisions without additional sampling.

- For analytes not detected or detected in less than 5 percent of the samples, all detection limits are below the PRGs/ESLs for surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples (see Attachment 1 for a more detailed discussion).

1.3 Data Quality Assessment

A data quality assessment (DQA) of the IDEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology DQOs through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA, and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology (DOE 2005a) and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the IDEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it not further evaluated. Arsenic was the only analyte in surface soil/surface sediment that had an MDC and UCL that exceeded the PRG, and it was retained as a PCOC.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, it was retained for further evaluation in the COC screen (Table 1.3).

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic is presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic (both IDEU and background) are provided in Attachment 3. Arsenic is the only PCOC that was statistically greater than

background at the 0.1 (1-p $\leq$ 0.1) significance level, and it is evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, risk potential, and pattern recognition. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic in surface soil/ surface sediment in the IDEU is not considered a COC because the weight of evidence supports the conclusion that arsenic concentrations in surface soil/surface sediment in the IDEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment at the IDEU were compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrient's MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 in subsurface soil/subsurface sediment were greater than the PRG; therefore, radium-228 was retained for further evaluation in the COC selection process in the IDEU.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed in Table 2.5, and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen was not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Analyses were conducted to asses whether radium-228 activities in IDEU subsurface soil/subsurface sediment are statistically higher than those in background subsurface soil/subsurface sediment at the 0.1 level of significance (1-p less than or equal to 0.1). The subsurface soil/subsurface sediment background data are described in detail in Appendix A, Volume 2 of the RI/FS Report.

The results of the statistical comparisons of the IDEU data to the background data indicate site activities for radium-228 are not statistically greater than background at the 0.1 significance level. The results are summarized in Table 2.3 and in Attachment 3. Box plots for radium-228 (both IDEU and background) are provided in Attachment 3. Radium-228 in subsurface soil/subsurface sediment was not further evaluated in the COC screening process.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations statistically greater than background concentrations.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the IDEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures for reasonably anticipated land use at RFETS. However, all PCOCs were eliminated from further consideration as human health COCs for the IDEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the IDEU; therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology (DOE 2005a). All PCOCs were eliminated from further consideration as human health COCs for the IDEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk

characterization is not necessary for the IDEU; therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment has been incorporated into this section to characterize risk to the WRW and WRV receptors. All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the IDEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties that are associated with the steps comprising an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated with the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the IDEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the IDEU were collected from 1992 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 83 samples in the IDEU. Although there is limited data for organics in surface soil/surface sediment, there are no known or suspected sources for organic contaminants in the IDEU. In subsurface soil/subsurface sediment, there are up to 72 samples in the IDEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated with Screening Values

The COC screening analyses used RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 milligrams (mg) of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air.

These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the IDEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely that a WRW will excavate extensively in the IDEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the IDEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic in surface soil/surface sediment was eliminated as a COC based on professional judgment. There is no identified source or pattern of release in the IDEU, and the slightly elevated median value of arsenic in the IDEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic are naturally occurring and are not the result of site activities. Uncertainty associated with the elimination of this chemical as a COC is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the IDEU.

6.4 Uncertainties Evaluation Summary

An evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the IDEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the IDEU. ECOIs are defined as any chemical detected in the IDEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15B of the RI/FS Report. The ECOPC process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the ecological SCM, including the receptors

of concern, exposure pathways, and endpoints used in the ERA for the IDEU, is also provided in Appendix A, Volume 2 of the RI/FS Report.

The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the IDEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soil.

The receptors of concern that were selected for assessment are listed in Table 7.1 and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC identification process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

7.1 Data Used in the Ecological Risk Assessment

The following IDEU data are used in the CRA:

- A total of 81 surface soil samples were collected and analyzed for inorganics (64 samples), organics (three samples), and radionuclides (81 samples) (Table 1.2); and

- A total of 72 subsurface soil samples were collected and analyzed for inorganics (72 samples), organics (65 samples), and radionuclides (70 samples) (Table 1.2).

A data summary is provided in Table 1.5 for surface soil and Table 1.7 for subsurface soil.

Sediment and surface water data for the IDEU also were collected (Section 1.1.5), and these data are evaluated for the ERA in Appendix A, Volume 15B of the RI/FS Report. As discussed in Section 8.0, surface water EPCs are used in the risk model to estimate exposure via the surface water ingestion pathway. Eleven distinct surface water samples were collected in the IDEU and analyzed for inorganics (11 samples), organics (seven samples), and radionuclides (10 samples).

The IDEU has eight sample locations occurring in or immediately adjacent to PMJM habitat, which is described in greater detail in Section 1.1.4. Surface soil samples were collected and analyzed for inorganics (seven out of eight samples) and radionuclides (four out of eight samples). There were no organic samples collected in PMJM habitat

(see Section 1.2). A data summary is provided in Table 1.6 for surface soil in PMJM habitat. Sampling locations and PMJM habitat patches within the IDEU are shown on Figure 1.5. The risk to the PMJM in habitat patch #5, which is partially located within IDEU, is evaluated in the RCEU. The risk to the PMJM in habitat patch #9 is evaluated in the IDEU even though the five samples used in the evaluation are outside the boundaries of IDEU (see Figure 1.5).

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are further evaluated.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity (UT) in Section 10.0 along with the potential impacts to the risk assessment.

PMJM Receptors

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" in the column heading "EPC>PMJM ESL?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "PMJM NOAEL ESL." These analytes are discussed in the uncertainty section (Section 10.0) as ECOIs with UT.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in

surface soil at the IDEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the IDEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparison are presented in Tables 7.4 and 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

The background comparison for PMJM receptors is performed using the same methods as for non-PMJM receptors, but the EU data set is restricted to soil samples from within PMJM habitat. Table 7.5 presents the results of the PMJM comparison to background. Attachment 3 presents further discussion of the PMJM background analysis. ECOIs listed as "Yes" on Table 7.5 are further evaluated in the professional judgment evaluation. No ECOIs in PMJM habitat were identified as needing further evaluation in professional judgment for the IDEU.

7.2.4 Exposure Point Concentration Comparisons to Threshold ESLs

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were then compared to threshold ESLs (tESLs) using upper-bound EPCs that are specific to small and large home-range receptors. The calculation of EPCs is described in Attachment 3 and Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL of the mean, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The upper-bound EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.7. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.8. There are no analytes exceeding limiting tESLs for large home-range receptors for the IDEU.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk assessment.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, arsenic, boron, chromium, lithium, and tin in surface soil at the IDEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

Antimony and lead were identified as ECOPCs and retained for further evaluation in the risk characterization.

PMJM Receptors

All ECOIs in PMJM habitat were eliminated from further consideration as ECOPCs in the preceding comparisons to NOAEL ESLs for PMJM or in the comparison to background. Therefore, no professional judgment evaluation is necessary.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized in the following section for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Most inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the IDEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in IDEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was

not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs and presented in Table 7.9.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.9. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the IDEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in the IDEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No ECOIs were retained as surface soil ECOPCs for PMJM receptors in the IDEU.

A summary of the ECOPC identification process for PMJM receptors is presented in Table 7.10.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the IDEU are identified on Figure 1.7. A data summary is presented in Table 1.7 for subsurface soil less than 8 feet deep.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil must be evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.11). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.11. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors includes an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.7. None of the chemicals in subsurface soil at the IDEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the IDEU.

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.12 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Attachment 3.

Analyses were conducted to assess whether arsenic, mercury, nickel, and vanadium in IDEU subsurface soil are statistically greater than those in sitewide background surface soil at the 0.1 level of significance. The results of the statistical comparisons of the IDEU data to background data indicate that site concentrations of arsenic, nickel, and vanadium in IDEU subsurface soil are not statistically greater than background concentrations. Statistical comparisons could not be completed for mercury because detection frequencies for either the background data set or IDEU data sets were too low. Mercury is evaluated further using upper-bound EPCs in the following section.

7.3.4 Exposure Point Concentration Comparisons to Threshold ESLs

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in the CRA Methodology (DOE 2005a).

Because only mercury was retained following the background analysis step, statistical concentrations for mercury are presented in Table 7.13. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.14. The subsurface soil UTL for mercury is lower than the tESL for the prairie dog receptor; therefore, mercury is not evaluated further.

7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of samples; have slightly elevated concentrations compared to the background data; and that exceed tESLs are subject to a professional judgment evaluation. However, no ECOIs had subsurface soil concentrations that exceeded tESLs; therefore, no weight-of-evidence, professional judgment evaluation was needed for subsurface soil in the IDEU.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the IDEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in IDEU subsurface soils was not greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.15.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the IDEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. Antimony and lead were identified as ECOPCs for selected non-PMJM receptors (Table 7.9). No chemicals were identified as ECOPCs for the PMJM (Table 7.10). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.15). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the IDEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Exposure to ECOPCs via the ingestion of surface water is also considered a potentially significant exposure route as presented in the CRA Methodology (DOE 2005a). Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods, as described in the CRA Methodology (DOE 2005a). Tier1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set, and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. The 30-acre grid used for the Tier 2 calculations is shown in Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Attachment 2 of the RI/FS Report.

The surface water EPCs were calculated for ECOIs that were identified as soil ECOPCs using the same statistical basis as determined for the soil ECOPCs. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was calculated as described for soils and selected as the EPC. Surface water EPCs for all ECOPCs are presented in Table 8.3. All surface water data are provided on the CD in Attachment 6.

8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. Specific factors include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology (DOE 2005a) and are presented in Table 8.4 for the receptors of potential concern carried forward in the ERA for the IDEU.

8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative bioaccumulation factors (BAFs) were identified in the CRA Methodology (DOE 2005a). These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The estimates use the default exposure parameters and BAFs that are presented in Appendix B of the CRA Methodology and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs including the Tier 1 and Tier 2 UTLs and UCLs.

Non-PMJM Receptors

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates is presented in Table 8.5.

- Antimony – Exposure estimates for the deer mouse (insectivore).
- Lead – Exposure estimates for the mourning dove (herbivore and insectivore).

9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior in Section 8.0 in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs used in screening steps of the ECOPC identification process to eliminate chemicals that do not have the potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and is calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology (DOE 2005a).

TRVs for ECOPCs identified for the IDEU were obtained from the CRA Methodology. The pertinent TRVs for the IDEU are presented for birds and mammals in Table 9.1.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the IDEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a hazard quotient (HQ) approach. An HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or LOEC):

$$HQ = \text{Exposure} / \text{TRV}$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (mg/kg soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg BW/day).

In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some

adverse effects are possible, although it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable. For threatened and endangered species, such as the PMJM, the interpretation of HQ results is based on potential risks to individuals rather than populations.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. The NOAEL and NOEC TRVs along with default screening-level exposure assumptions are first used to calculate HQs. However, these no effects HQs are typically considered as screening level results and do not necessarily represent realistic risks for the site. EPA risk assessment guidance (EPA 1997) recommends a tiered approach to evaluation, and following the first tier of evaluation "the risk assessor should review the assumptions used (e.g., 100 percent bioavailability) against values reported in the literature (e.g., only up to 60 percent for a particular contaminant), and consider how the HQs would change if more realistic conservative assumptions were used instead." Accordingly, LOAEL and threshold TRVs are also used in this evaluation to calculate HQs. Where LOAEL HQs greater than 1 are calculated using default exposure assumptions, and the uncertainty analysis indicates that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated.

10.1 Chemical Risk Characterization

Chemical risk characterization involves quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

HQ Values		Interpretation of HQ Results
NOAEL-based	**LOAEL-based**	
≤ 1	≤ 1	Minimal or no risk
> 1	≤ 1	Low-level risk[a]
> 1	> 1	Potential adverse effects

[a] Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty described below.

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on both Tier 1 and Tier 2 EPCs for non-PMJM receptors. No Tier 2 EPCs were calculated for PMJM receptors due to the limited size of their habitat.

- **BAFs.** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (Eco-SSL) guidance (EPA 2005).

- **TRVs.** The CRA Methodology utilized an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection process. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed on a chemical-by-chemical basis in the following subsections. When an

alternative TRV is identified, the chemical-specific subsections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated both alone and in concert in the risk description for each chemical. Uncertainties related to the BAFs, TRVs, and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provides alternative BAFs and/or TRVs that are then incorporated into the risk characterization as appropriate.

HQs calculated using the default BAFs and HQs with the Tier 1 and Tier 2 EPCs are provided in Table 10.1 for each ECOPC/receptor pair. Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated. Since the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

Where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicates that median BAFs and/or additional TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated and presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance and will depend on the type of receptor and the relative home-range size. Only the UTL EPC is provided in Table 10.1 for small home-range receptors, and only the UCL is provided for large home-range receptors. Only small home-range receptors are of concern in the IDEU.

All calculated exposure estimates and HQ values are provided in Attachment 4. These include the default and refined HQs if needed. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimates and other lines of evidence to evaluate potential chemical effects on ecological receptors in the IDEU following accelerated actions at RFETS. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU concentrations to other criteria such as EPA Eco-SSLs, and risk above background conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the IDEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

10.1.1 Antimony

Antimony HQs for the deer mouse (insectivore) are presented in Table 10.1. Figure 10.1 shows the spatial distribution of antimony in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

For the deer mouse (insectivore), the only non-PMJM receptor, LOAEL HQs were less than 1 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Antimony – Risk Description

Antimony was identified as an ECOPC for the deer mouse (insectivore). Information on the historical use and a summary of site data and background data is provided in Attachment 3.

Non-PMJM Receptors – Small Home Range

Potential risks to vertebrate non-PMJM receptors were evaluated and HQs are presented in Table 10.1. NOAEL HQs were greater than 1 for the deer mouse (insectivore) using both the Tier 1 and Tier 2 EPCs. LOAEL HQs were less than or equal to 1 using the Tier 1 and Tier 2 EPCs, respectively. Therefore, risks to populations of the deer mouse (insectivore) from exposure to antimony are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Antimony samples were available from 41 grid cells (Figure 10.1). NOAEL HQs greater than 1 were calculated in 32 percent of the grid cells, and no LOAEL HQs greater than 1 were calculated in any grid cell for the deer mouse (insectivore). The results of the grid-cell analysis indicate that the average exposure to sub-populations of deer mice (insectivore) results in low risk from exposure to antimony.

10.1.2 Lead

Lead HQs for the mourning dove (herbivore and insectivore) are presented in Table 10.1. Figure 10.2 shows the spatial distribution of lead in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs.

LOAEL HQs greater than 1 (HQs = 3) were calculated for the mourning dove (insectivore) receptor using the default exposure assumptions. As discussed in the uncertainty analysis presented in Attachment 5, no additional HQs could be calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Lead Risk Description

Lead was identified as an ECOPC for the mourning dove (herbivore and insectivore) receptors only. Information on the historical use provided in Appendix A, Volume 2, Attachment 8 of the RI/FS Report and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home Range

NOAEL HQs were greater than 1 for the mourning dove (insectivore) and equal to 1 for the mourning dove (herbivore) (Table 10.1). LOAEL HQs were also greater than 1 (HQ = 3) using both the Tier 1 and Tier 2 EPCs for the mourning dove (insectivore) but less than or equal to 1 for the mourning dove (herbivore). The potential for adverse effects to the mourning dove (herbivore) are, therefore, likely to be low from exposure to lead. The potential for adverse effects to the mourning dove (insectivore) requires further evaluation.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Lead samples were available from 41 grid cells (Figure 10.2). NOAEL HQs greater than 1 were calculated in 97 percent of the grid cells, while 92 percent of the LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). Only 2 percent of the LOAEL HQs (one grid cell) were greater than 5 for the mourning dove (insectivore). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors requires further evaluation.

The uncertainty analysis indicates that LOAEL HQs calculated using the default upper-bound BAF and the default TRV may be overestimated for the mourning dove (insectivore). However, no median BAF or additional TRVs are available for a refined analysis.

LOAEL HQs for the mourning dove (insectivore) are also equal to 3 using the site-specific background UTL and default risk model as calculated in Appendix A, Volume 2, Attachment 9 of the RI/FS Report. These background calculations are also discussed in Attachment 5 of this document. Attachment 3 of this document indicates that the background concentrations of lead in Colorado and bordering states range from 10 to 700 milligrams per kilogram (mg/kg). The site-specific background UTL is equal to 53.3 mg/kg and does not appear to be elevated above what would be expected in the vicinity of the site. The Tier 1 IDEU UTL is equal to 62.8 mg/kg and the Tier 2 UTL is equal to 40.4 mg/kg. Although lead concentrations in the IDEU are statistically greater than background, potential adverse effects in IDEU are no greater than those predicted in background and background lead concentrations do not appear to be elevated above what would be expected in the vicinity of the site.

Based on the LOAEL HQs using the default risk model, potential adverse effects to mourning dove (insectivore) populations are likely to be low to moderate; however, risks to the mourning dove (insectivore) receptor in the IDEU are similar to background risks.

10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991 when baseline data on wildlife species were gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. Although a comprehensive compilation of monitoring results has not been presented, the annual reports of the monitoring program provide localized information and insights on the general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for more than a decade (K-H 2002a). Observations were recorded concerning the abundance, distribution, and diversity of wide-ranging wildlife species, including observations of migratory birds, raptors, coyotes, and deer.

Migratory birds were tracked during all seasons, but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands, and wetlands. However, summaries in annual reports are grouped by habitat types across RFETS and not within EUs, because EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991, 1993-1999) and show a steady state in diversity of bird communities (K-H 2000). Results among habitats were similar with the exception of an increasing trend in species richness and a decreasing trend in bird densities in woodland habitats. Woodland bird communities consistently show the highest diversity when compared with bird communities in wetlands and grasslands. The decreasing trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tailed hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of nesting sites in Upper Woman Creek during the survey period. Goldfinch abundance can be heavily influenced by the availability of food sources.

A subgroup of migratory birds is the neotropical migrants, which show declining populations in North America (Audubon 2005, Nature Conservancy 2005). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics and conversion to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years on RFETS, the declining trends have not been observed, and densities for this group show an increase.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provide species-specific

sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors at RFETS are red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002). One Swainson's hawk nest was noted in North Walnut Creek near the A-1 Pond, and one great horned owl nest was observed within South Walnut Creek. All nests typically fledged two young of each species, except kestrels, which usually fledged two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999, with a single exception. This exception was the loss of the red-tailed hawk nest in Upper Woman Creek (K-H 1998a and 1999a) due to weather. The continued presence of nesting raptors at RFETS (K-H 2002a) indicates that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given the available habitat and the territorial nature of these species (K-H 2000a).

Two deer species inhabit RFETS: white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*). No white-tailed deer were present at RFETS in 1991 when monitoring began (K-H 2002a). In 2000 (K-H 2001a), the number of white-tailed deer was estimated to be between 10 and 15 individuals. White-tailed deer frequent other areas within RFETS but spend the majority of their time in LWOEU. Mule deer frequent all parts of RFETS (14 mi^2) year-round. The RFETS population from winter counts is estimated at a mean 125 individuals (n = 7) with a density of 14 deer per square mile (K-H 2000a, 2002a). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000) with expected age/sex class distributions (K-H 2001a). Mule deer frequent grassland hillsides during the fall and winter months. The mule deer populations from RFETS have been increasing at a steady state, with good age/sex distributions (K-H 2001a) over time and similar densities when compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (Canis latrans) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002a). Through surveys across the site, coyotes have been noted as having reproduction success with as many as six dens active in 1 year. Typically at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H 2001a). Coyotes have exhibited a steady population over time indicating their prey species continue to be abundant and healthy.

Small mammal trapping has not occurred in the IDEU. However, small mammal habitats such as xeric grasslands throughout the EU and riparian shrublands in the upper reach of North Walnut Creek exist and likely support small mammal communities similar to those found sitewide. Vegetation communities that create small mammal habitat have been

monitored in the EU through the Ecological Monitoring Program (K-H 1998b, 1999b, 2000b, 2001b, 2002b), especially under the High Value Vegetation Program. Continuous long-term monitoring has revealed that the flora for the site is extremely rich for an area of its size (K-H 2002b). The high diversity of vegetation communities and the undisturbed nature of the BZ, including the IDEU, support rich and diverse small mammal habitats in the EU, which appear healthy and robust.

The high species diversity and continued use of the site by numerous vertebrate species verifies that habitat quality for these species remains acceptable and the ecosystem functions are being maintained (K-H 2000a). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS.

10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on the risk characterization in the risk description section for each ECOPC. The following general uncertainties associated with the ERAs for all the EUs may under- or overestimate risk to an unknown degree; a full discussion of these general uncertainties is provided in Volume 2 of Appendix A of the RI/FS Report:

- Uncertainties associated with data quality and adequacy;
- Uncertainties associated with the ECOPC identification process;
- Uncertainties associated with the selection of representative receptors;
- Uncertainties associated with exposure calculations;
- Uncertainties associated with the development of NOAEL ESLs;
- Uncertainties associated with the lack of toxicity data for ECOIs; and
- Uncertainties associated with eliminating ECOIs based on professional judgment.

The following sections are potential sources of uncertainty that are specific to the IDEU ERA.

10.3.1 Uncertainties Associated with Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the IDEU, respectively. A more detailed discussion is presented in Appendix A, Volume 2, Attachments 2 and 3 of the RI/FS Report, and Attachment 2 of this volume. The data quality assessment indicates the data are of sufficient quality for use in the CRA. The adequacy of the IDEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. The assessment indicates there is limited data for VOCs and SVOCs in surface soil, no organic data for surface soil in the PMJM habitat patches, and no organic data (except VOCs) for surface water. However, PAC 000-501 (Roadway Spray Areas) is the only historical IHSS in the IDEU where organics may have been released (in this case, PAHs). In the IDEU and other EUs that contain this former IHSS, organics were not detected at detections limits near or below the ESLs. The IDEU is also hydraulically isolated from potential historical source areas in and near the IA. Therefore, organics are not likely to be present in surface soil or surface water, and it is possible to make risk management decisions without additional sampling. Data used in the CRA must have detection limits to allow meaningful comparison to ESLs. When these detection limits exceed the respective ESLs, this is a source of uncertainty in the risk assessment. Attachment 1 to this volume provides a detection limit adequacy screen where detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to ESLs. All detection limits are below the ESLs for surface soil and subsurface soil samples.

10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Inter-Drainage Exposure Unit

Several ECOIs detected in the IDEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.3, and 7.11 with a "UT" designation. Included as a subset of the ECOIs with a "UT" designation are the essential nutrients (calcium, iron, magnesium, potassium, and sodium). Although these nutrients may be potentially toxic to certain ecological receptors at high concentrations, the uncertainty associated with the toxicity of these nutrients is expected to be low. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, although the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

ESLs were not available for one of the ECOPC/receptor pairs identified in Section 7.0, antimony (birds). Therefore, the risks to birds from exposure to antimony are uncertain. However, because the risks are considered to be low for other receptors where toxicity information is available, this source of uncertainty is not expected to be significant.

10.3.3 Uncertainties Associated with Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the IDEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the IDEU, and the slightly elevated values of the IDEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation is unlikely to have significant effect on the overall risk calculations because the ECOIs eliminated from further consideration are found at concentrations in IDEU that are at levels that are unlikely to result in risk concerns for ecological receptors and are well within regional background levels. In addition, these ECOIs are not related to site-activities in the IDEU and have very low potential to be transported from historical sources to the IDEU.

10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the general sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA Methodology outlines a tiered process of risk evaluation that includes conservative assumptions for the ECOPC identification process and more realistic assumptions, as appropriate, for risk characterization.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the IDEU is presented below.

11.1 Data Adequacy

The adequacy of the IDEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. The assessment indicates an absence of surface soil, sediment, and surface water data for some organic analyte groups, and limited data for other organic analyte groups. However, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) indicate that organic analytes are not likely to be present in these IDEU media, and therefore, are not of concern to human or ecological receptors. In addition, for analytes that are not detected or detected at a frequency less than 5 percent, all detection limits are below the PRGs/ESLs for surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples, which indicates detection limits are not a source of uncertainty in the risk assessment.

11.2 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in IDEU media to PRGs for the WRW receptor. PCOCs with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic analytes that were statistically greater than background at the 0.1 significance level and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the IDEU and a risk characterization was not performed for the IDEU. Only one analyte, arsenic, had concentrations in IDEU surface soil/surface sediment that were statistically greater than RFETS background. However, arsenic was subsequently eliminated as a COC in the professional judgment evaluation of the COC selection process because the weight of evidence supports the conclusion that concentrations of arsenic in the IDEU are not the result of RFETS activities, but rather are representative of naturally occurring concentrations. For comparison purposes, the cancer risks and noncancer hazard quotients (HQs) were estimated for the WRW and WRV for arsenic in IDEU surface soil/surface sediment and in RFETS background surface soil/surface sediment. The estimated cancer risks for the WRW and WRV associated with potential exposure to arsenic in surface soil/surface sediment in the IDEU are both approximately 3E-06. The estimated HQs associated with potential exposure to arsenic in surface soil/surface sediment in the IDEU are approximately 0.02 for the WRW and 0.01 for the WRV. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of arsenic in surface soil/surface sediment at RFETS are 2E-06 and 1E-06, respectively. The estimated HQs associated with potential exposure to RFETS background levels of arsenic in surface soil/surface sediment are approximately 0.01 for the WRW and 0.007 for the WRV. No analytes in subsurface soil/subsurface sediment were statistically greater than RFETS background. These results indicate that potential health risks for the WRW and WRV in the IDEU are expected to be similar to background risks, and there are no significant human health risks from RFETS-related operations at the IDEU.

11.3 Ecological Risk

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the IDEU. The ECOPC identification process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. Only two ECOIs in surface soil (antimony and lead) were identified as ECOPCs for representative populations of non-Preble's meadow jumping mouse (PMJM) receptors. No ECOPCs were identified for individual PMJM receptors in surface soil. Although there are no dioxin data for surface soil, the evaluation of site-wide data indicate dioxins are not expected to be present in IDEU surface soil, however, there is some uncertainty in the overall risk estimates for the IDEU as a result of this data limitation. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology (DOE 2005a). Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were considered to provide a refined estimate of potential risk.

Using Tier 1 EPCs and the default exposure and risk assumptions, NOAEL HQs ranged from 1 (lead/mourning dove-herbivore) to 4 (antimony/deer mouse-insectivore and lead/mourning dove-insectivore). Using Tier 2 EPCs, NOAEL HQs ranged from 1 (lead/mourning dove-herbivore) to 11 (antimony/deer mouse-insectivore) (Table 10.1).

Using Tier 1 and Tier 2 EPCs, two of three ECOPC/receptor pairs had LOAEL HQs less than or equal to 1 using the default assumptions used in the risk calculations. However, the lead/mourning dove-insectivore receptor pair had LOAEL HQs greater than 1 using the default exposure and toxicity assumptions:

- Lead/mourning dove (insectivore) – LOAEL HQs were equal to 3 using Tier 1 and Tier 2 EPCs. No median BAFs or additional TRVs were available for a refined risk analysis. Therefore, potential adverse effects to mourning dove (insectivore) populations are likely to be low to moderate. However, the LOAEL HQ based on the default ESL and the background UTL is the same as the LOAEL HQ based on the default ESL and IDEU UTL (HQs = 3). Therefore, risks from exposure to lead in soil in the IDEU are essentially the same as risks in background areas.

Based on the default calculations, site-related risks are likely to be low to moderate for the ecological receptors evaluated in the IDEU (Table 11.1). For the one ECOPC/receptor pair with a LOAEL HQ greater than one (lead/mourning dove [insectivore]), risks in the IDEU are essentially the same as risks in background areas. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the IDEU.

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TABLES

Table 1.1
IDEU IHSSs

IHSS	OU	PAC	Title	Description	Disposition
168	11[a]	000-168	West Spray Field	Excess water from the Solar Evaporation Ponds (IHSS 101) was sprayed in this area between April 1982 and October 1985. The ponds were used primarily for the evaporation of low-level radioactive wastes contaminated with high concentrations of nitrate.	NFA CAD/ROD - 1995
--	BZ	000-501	Roadway Spraying	Roadways in the BZ OU were sprayed with waste oils for dust suppression; reverse osmosis brine solutions and footing drain water were also applied.[b]	NFA -2005 HRR
--	BZ	NE-1400	Tear Gas Powder Release	Five pounds of CS tear gas powder spilled on the roadway in the BZ on the evening of August 5, 1987. The powder became airborne due to automotive traffic.	NFA -2005 HRR
195	16[a]	NW-195	Nickel Carbonyl Disposal	This site contains a drywell that was used to decompose approximately 185 pounds of nickel carbonyl gas between March and September 1972.	NFA OU 16 CAD/ROD - 1994

[a]IAG OU

[b]PAC 000-501 was one of 79 IHSSs/PACs proposed for NFA by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al. 2002).

Table 1.2
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a,b]	Surface Soil[c]	Surface Soil (PMJM)[c]	Subsurface Soil[c]
Inorganics	64	72	64	N/A	72
Organics	3	65	3	N/A	65
Radionuclides	83	70	81	1[d](8)[e]	70

[a] Used in the HHRA.

[b] Same as subsurface soil - no data for sediment greater than 0.5 ft

[c] Used in the ERA.

[d] Number of samples in IDEU PMJM patches.

[e] Total number of samples used in ERA for PMJM. For IDEU, the data for surface soil samples adjacent to IDEU PMJM habitat patches are used to complement the sample collected within the patches (see figure 1.5).

N/A = Not applicable.

Note: The total number of results (samples) for the analytes presented in Tables 1.3 through 1.7 may differ from the number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)									
Aluminum	4.8 - 40	64	100			7,340	35,000	13,234	5,151
Antimony	0.28 - 12	64	14.1	0.280	9.80	0.330	3.50	1.39	0.923
Arsenic	0.81 - 2	64	100			4	17	7.78	1.90
Barium	0.37 - 40	64	100			62	199	124	21.8
Beryllium	0.1 - 1	64	90.6	0.580	0.890	0.500	1.90	0.664	0.226
Boron	1 - 1.2	14	78.6	4.50	5.80	4.30	9.70	5.64	2.19
Cadmium	0.064 - 1	64	42.2	0.0640	0.720	0.600	1.40	0.484	0.363
Calcium	7 - 1,000	64	100			1,540	4,370	2,473	487
Chromium	0.15 - 2	64	100			9.30	26	13.7	3.83
Cobalt	0.18 - 10	64	100			3.30	11.2	6.22	1.26
Copper	0.045 - 5	64	100			5.30	88.1	13.4	9.87
Iron	1.4 - 20	64	100			9,900	23,700	13,794	2,694
Lead	0.27 - 0.6	64	100			9.50	82.9	39.9	13.3
Lithium	0.48 - 20	64	100			5.50	19.4	10.2	2.94
Magnesium	7.5 - 1,000	64	100			1,280	3,700	1,821	446
Manganese	0.17 - 3	64	100			45	558	300	78.2
Mercury	0.0069 - 0.1	64	21.9	0.0800	0.170	0.00940	0.0380	0.0451	0.0141
Molybdenum	0.29 - 40	64	37.5	0.310	1.80	0.360	2.60	0.768	0.448
Nickel	0.19 - 8	64	100			5.10	32	9.86	4.50
Nitrate / Nitrite	0.1 - 0.1	50	100			2	37	13.0	11.6
Potassium	35 - 1,000	64	100			1,280	4,400	2,148	677
Selenium	0.79 - 1	64	42.2	0.390	0.930	0.400	0.680	0.385	0.134
Silica[c]	4.3 - 5	14	100			510	850	703	92.1
Silver	0.077 - 2	64	6.25	0.0780	1.20	0.0850	0.600	0.207	0.118
Sodium	130 - 1,000	64	78.1	130	150	39.3	131	71.8	18.3
Strontium	0.058 - 40	64	100			14.8	41.6	22.5	4.29
Thallium	0.9 - 2	64	31.3	0.200	1.10	0.190	0.270	0.232	0.150
Tin[c]	0.84 - 40	64	21.9	0.840	6.90	2.40	4.90	1.82	1.02
Titanium[c]	0.087 - 0.1	14	100			110	340	248	67.4

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Uranium[c]	1.4 - 1.6	14	7.14	1.40	1.60	2.40	2.40	0.879	0.440
Vanadium	0.46 - 10	64	100			23	71	31.1	8.20
Zinc	0.45 - 4	64	100			23	70	42.7	9.12
Radionuclides (pCi/g)[d]									
Americium-241	0.006 - 0.298	62	N/A			-0.0820	0.430	0.0305	0.0593
Gross Alpha	4 - 30	8	N/A			13	79	30.1	24.0
Gross Beta	4 - 20	8	N/A			36	69	44.9	11.3
Plutonium-239/240	0.002 - 0.163	82	N/A			-0.00869	2.20	0.133	0.237
Radium-226	0.71 - 0.71	1	N/A			1.90	1.90	1.90	N/A
Uranium-233/234	0.01 - 0.388	64	N/A			0.246	15	1.96	1.81
Uranium-235	0.009 - 0.388	64	N/A			-0.0126	0.460	0.0879	0.0764
Uranium-238	0.02 - 0.282	64	N/A			0.551	13	1.96	1.56

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.4

Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment [a]

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)									
Aluminum	4.6 - 40	72	98.6	2.60	2.60	1,420	52,000	10,202	8,534
Antimony	0.27 - 12	72	4.17	0.280	33.8	0.270	3.30	1.98	2.23
Arsenic	0.2 - 2	72	100			1.30	16	4.79	2.46
Barium	0.35 - 40	72	98.6	0.210	0.210	13.2	160	56.9	30.5
Beryllium	0.097 - 1	70	94.3	0.210	0.760	0.260	2.10	0.692	0.369
Calcium	3.5 - 1,000	72	98.6	1.30	1.30	195	71,900	2,521	8,415
Cesium[d]	94.4 - 200	61	14.8	8.50	101	1.10	6.60	5.59	8.10
Chromium	0.14 - 2	72	88.9	0.430	15.5	4.40	77.5	17.7	13.4
Cobalt	0.18 - 10	72	98.6	0.640	0.640	1	91.6	7.03	10.6
Copper	0.043 - 5	71	98.6	0.430	0.430	2.60	19.7	8.62	4.16
Iron	1.3 - 20	72	98.6	5.40	5.40	2,790	30,900	11,231	4,955
Lead	0.19 - 1.1	72	100			3.50	17.5	7.16	3.32
Lithium	0.47 - 20	72	94.4	0.210	6	1.60	22	5.27	3.59
Magnesium	6.7 - 1,000	72	98.6	3	3	225	5,100	1,248	914
Manganese	0.17 - 3	72	98.6	0.210	0.210	16.3	885	161	135
Mercury	0.0066 - 0.11	72	19.4	0.0500	0.170	0.0470	25.4	0.413	2.99
Molybdenum	0.28 - 40	71	35.2	0.630	11.7	0.440	15.6	1.97	2.39
Nickel	0.19 - 8	72	84.7	3	22.7	1.40	49	11.0	7.93
Nitrate / Nitrite	0.1 - 0.1	55	90.9	0.100	0.100	0.100	2	0.519	0.553
Potassium	34 - 1,000	72	84.7	83.6	2,090	331	2,760	830	521
Selenium	0.2 - 1	70	10	0.200	0.830	0.360	0.590	0.241	0.103
Silica[d]	4.1 - 4.5	6	100			530	740	590	76.2
Silicon[d]	0 - 0	2	100			27.1	30.9	29	2.69
Silver	0.074 - 2	70	5.71	0.0770	2.90	0.170	0.550	0.285	0.237
Sodium	7 - 1,000	72	91.7	120	220	19.5	965	118	152
Strontium	0.056 - 40	72	98.6	0.210	0.210	3.10	77.6	16.3	14.4
Thallium	0.29 - 2	72	5.56	0.200	0.940	0.210	0.320	0.168	0.102
Tin[c]	0.81 - 40	72	12.5	0.830	44	2.50	46.5	3.98	7.99
Titanium[d]	0.084 - 0.09	6	100			66	250	121	66.4
Uranium[d]	1.3 - 1.5	6	16.7	1.30	1.40	1.60	1.60	0.842	0.372
Vanadium	0.44 - 10	72	98.6	0.430	0.430	6.10	91.9	25.0	13.7
Zinc	0.43 - 4	72	90.3	0.430	15.1	3.20	64.5	14.4	10.6

Table 1.4

Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment [a]

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Organics (ug/kg)									
2-Butanone	10 - 113	45	2.22	9.50	13	4	4	5.22	0.369
Acetone	10 - 113	40	22.5	10	25.3	1	20	6.70	3.61
bis(2-Ethylhexyl)phthalate	10 - 330	55	41.8	340	370	36	100	124	63.1
Chloroform[d]	4.97 - 5.69	54	1.85	0.850	7	96	96	4.11	12.8
	10 - 330	55	3.64	340	650	190	240	175	10.2
Di-n-butylphthalate	10 - 330	55	41.8	330	370	39	520	231	111
Methylene chloride	4.97 - 5.69	52	25	1.23	36	1	16	3.45	3.17
Toluene	4.97 - 5.69	54	38.9	1.25	6	1	36	3.73	5.74
Xylene	5 - 11.3	54	1.85	2.48	7	5	5	2.52	0.583
Radionuclides (pCi/g)[e]									
Americium-241	0 - 0.216	63	N/A			-0.0526	0.0628	0.00653	0.0136
Cesium-134	0.02 - 0.02	2	N/A			0.0300	0.0300	0.0300	0
Cesium-137	0.02 - 0.06	4	N/A			0.0342	0.0600	0.0474	0.0146
Gross Alpha	2 - 22.18	9	N/A			8.03	31.3	16.1	8.50
Gross Beta	2.4 - 5.73	10	N/A			4.00	36.6	19.1	10.9
Plutonium-239/240	0 - 0.214	67	N/A			-0.00400	0.690	0.0227	0.0902
Radium-226	0.2 - 0.21	4	N/A			0.579	1.55	1.04	0.459
Radium-228	0.07 - 0.08	4	N/A			0.890	1.35	1.16	0.193
Strontium-89/90	0.03 - 0.7828	6	N/A			-0.0997	0.121	0.0269	0.0750
Uranium-233/234	0.012 - 0.139	67	N/A			0.444	3.20	1.39	0.521
Uranium-235	0 - 0.302	67	N/A			-0.0395	0.181	0.0660	0.0410
Uranium-238	0 - 0.16	67	N/A			0.214	3.10	1.37	0.539

[a] Same as subsurface soil - no data for sediment greater than 0.5 ft. bgs.

[b] Values in this column are reported results for nondetects (i.e., U-qualified results).

[c] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[d] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[e] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)									
Aluminum	4.8 - 40	64	100			7,340	35,000	13,234	5,151
Antimony	0.28 - 12	64	14.1	0.280	9.80	0.330	3.50	1.39	0.923
Arsenic	0.81 - 2	64	100			4	17	7.78	1.90
Barium	0.37 - 40	64	100			62	199	124	21.8
Beryllium	0.1 - 1	64	90.6	0.580	0.890	0.500	1.90	0.664	0.226
Boron	1 - 1.2	14	78.6	4.50	5.80	4.30	9.70	5.64	2.19
Cadmium	0.064 - 1	64	42.2	0.0640	0.720	0.600	1.40	0.484	0.363
Calcium	7 - 1,000	64	100			1,540	4,370	2,473	487
Chromium	0.15 - 2	64	100			9.30	26	13.7	3.83
Cobalt	0.18 - 10	64	100			3.30	11.2	6.22	1.26
Copper	0.045 - 5	64	100			5.30	88.1	13.4	9.87
Iron	1.4 - 20	64	100			9,900	23,700	13,794	2,694
Lead	0.27 - 0.6	64	100			9.50	82.9	39.9	13.3
Lithium	0.48 - 20	64	100			5.50	19.4	10.2	2.94
Magnesium	7.5 - 1,000	64	100			1,280	3,700	1,821	446
Manganese	0.17 - 3	64	100			45	558	300	78.2
Mercury	0.0069 - 0.1	64	21.9	0.0800	0.170	0.00940	0.0380	0.0451	0.0141
Molybdenum	0.29 - 40	64	37.5	0.310	1.80	0.360	2.60	0.768	0.448
Nickel	0.19 - 8	64	100			5.10	32	9.86	4.50
Nitrate / Nitrite	0.1 - 0.1	50	100			2	37	13.0	11.6
Potassium	35 - 1,000	64	100			1,280	4,400	2,148	677
Selenium	0.79 - 1	64	42.2	0.390	0.930	0.400	0.680	0.385	0.134
Silica[b]	4.3 - 5	14	100			510	850	703	92.1
Silver	0.077 - 2	64	6.25	0.0780	1.20	0.0850	0.600	0.207	0.118
Sodium	130 - 1,000	64	78.1	130	150	39.3	131	71.8	18.3
Strontium	0.058 - 40	64	100			14.8	41.6	22.5	4.29
Thallium	0.9 - 2	64	31.3	0.200	1.10	0.190	0.270	0.232	0.150
Tin[b]	0.84 - 40	64	21.9	0.840	6.90	2.40	4.90	1.82	1.02
Titanium[b]	0.087 - 0.1	14	100			110	340	248	67.4
Uranium[b]	1.4 - 1.6	14	7.14	1.40	1.60	2.40	2.40	0.879	0.440
Vanadium	0.46 - 10	64	100			23	71	31.1	8.20
Zinc	0.45 - 4	64	100			23	70	42.7	9.12
Radionuclides (pCi/g)[c]									
Americium-241	0.007 - 0.298	61	N/A			-0.0820	0.430	0.0307	0.0598
Gross Alpha	20 - 30	6	N/A			13	22	17.7	2.94
Gross Beta	20 - 20	6	N/A			36	44	39.5	3.62
Plutonium-239/240	0.002 - 0.163	81	N/A			-0.00869	2.20	0.135	0.238
Uranium-233/234	0.01 - 0.388	63	N/A			0.246	4.30	1.75	0.732
Uranium-235	0.009 - 0.388	63	N/A			-0.0126	0.300	0.0820	0.0605
Uranium-238	0.02 - 0.282	63	N/A			0.551	4.50	1.79	0.683

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.6
Summary of Detected Analytes in Surface Soil (PMJM Habitat) in the IDEU

Analyte	Units	Number of Detects	Number of Samples	Detection Frequency (%)	Minimum Reported Detection Limit	Maximum Reported Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation[a]
Inorganics										
Aluminum	mg/kg	7	7	100	1.2	200	3,120	12,100	8,454.29	3,447.54
Arsenic	mg/kg	7	7	100	0.59	10	1.5	7.6	4.30	2.90
Barium	mg/kg	7	7	100	0.039	200	25.3	132	87.49	43.89
Beryllium	mg/kg	6	7	85.71429	0.031	5	0.3	0.74	0.45	0.22
Boron	mg/kg	3	3	100	0.35	0.37	1.1	5	2.57	2.12
Cadmium	mg/kg	2	7	28.57143	0.048	5	0.74	0.85	0.31	0.35
Calcium	mg/kg	7	7	100	3.2	5,000	2,280	6,960	4,135.71	1,908.53
Chromium	mg/kg	7	7	100	0.054	10	7.7	15.8	11.91	2.95
Cobalt	mg/kg	7	7	100	0.08	50	1.6	10.8	5.27	3.00
Copper	mg/kg	7	7	100	0.16	25	7	38	15.74	10.74
Iron	mg/kg	7	7	100	1.5	100	5,610	25,900	13,032.86	6,439.42
Lead	mg/kg	7	7	100	0.2	3	4.8	41.6	20.66	15.79
Lithium	mg/kg	7	7	100	0.18	100	3.5	12.4	7.39	2.87
Magnesium	mg/kg	7	7	100	1.7	5,000	1240	6,490	2,691.43	1,913.33
Manganese	mg/kg	7	7	100	0.033	15	96.1	556	271.59	151.52
Mercury	mg/kg	3	7	42.85714	0.0012	0.2	0.003	0.0038	0.03	0.03
Molybdenum	mg/kg	3	7	42.85714	0.13	40	0.28	0.42	0.73	0.55
Nickel	mg/kg	7	7	100	0.65	40	4.5	10.7	8.17	2.14
Nitrate / Nitrite	mg/kg	3	3	100	0.1	0.1	20	26	22.67	3.06
Potassium	mg/kg	7	7	100	42.5	5,000	616	4,730	1,791.86	1,391.89
Selenium	mg/kg	3	7	42.85714	0.45	5	0.45	0.58	0.37	0.16
Silica	mg/kg	3	3	100	2.7	2.8	672	833	764.00	82.93
Sodium	mg/kg	6	7	85.71429	104	5,000	51.4	6,510	1,589.06	2,428.55
Strontium	mg/kg	7	7	100	0.0062	200	14.3	35.1	22.53	6.37
Titanium	mg/kg	3	3	100	0.19	0.19	159	433	268.67	144.95
Vanadium	mg/kg	7	7	100	0.25	50	11.8	42	26.60	9.89
Zinc	mg/kg	7	7	100	0.21	20	17.5	138	44.84	42.12
Radionuclidesc										
Americium-241	pCi/g	4	4	100	0.008	0.1142	0.0044	0.025	0.02	0.01
Plutonium-239/240	pCi/g	4	4	100	0.004	0.0482	0.0123	0.11	0.07	0.04
Uranium-233/234	pCi/g	3	3	100	0.022	0.083	1.3	2.1	1.77	0.42
Uranium-235	pCi/g	3	3	100	0.022	0.094	0.064	0.077	0.07	0.01
Uranium-238	pCi/g	3	3	100	0.022	0.14	1.6	2	1.80	0.20

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)									
Aluminum	4.6 - 40	72	98.6	2.60	2.60	1,420	52,000	10,202	8,534
Antimony	0.27 - 12	72	4.17	0.280	33.8	0.270	3.30	1.98	2.23
Arsenic	0.2 - 2	72	100			1.30	16	4.79	2.46
Barium	0.35 - 40	72	98.6	0.210	0.210	13.2	160	56.9	30.5
Beryllium	0.097 - 1	70	94.3	0.210	0.760	0.260	2.10	0.692	0.369
Calcium	3.5 - 1,000	72	98.6	1.30	1.30	195	71,900	2,521	8,415
Cesium[b]	94.4 - 200	61	14.8	8.50	101	1.10	6.60	5.59	8.10
Chromium	0.14 - 2	72	88.9	0.430	15.5	4.40	77.5	17.7	13.4
Cobalt	0.18 - 10	72	98.6	0.640	0.640	1	91.6	7.03	10.6
Copper	0.043 - 5	71	98.6	0.430	0.430	2.60	19.7	8.62	4.16
Iron	1.3 - 20	72	98.6	5.40	5.40	2,790	30,900	11,231	4,955
Lead	0.19 - 1.1	72	100			3.50	17.5	7.16	3.32
Lithium	0.47 - 20	72	94.4	0.210	6	1.60	22	5.27	3.59
Magnesium	6.7 - 1,000	72	98.6	3	3	225	5,100	1,248	914
Manganese	0.17 - 3	72	98.6	0.210	0.210	16.3	885	161	135
Mercury	0.0066 - 0.11	72	19.4	0.0500	0.170	0.0470	25.4	0.413	2.99
Molybdenum	0.28 - 40	71	35.2	0.630	11.7	0.440	15.6	1.97	2.39
Nickel	0.19 - 8	72	84.7	3	22.7	1.40	49	11.0	7.93
Nitrate / Nitrite	0.1 - 0.1	55	90.9	0.100	0.100	0.100	2	0.519	0.553
Potassium	34 - 1,000	72	84.7	83.6	2,090	331	2,760	830	521
Selenium	0.2 - 1	70	10	0.200	0.830	0.360	0.590	0.241	0.103
Silica[b]	4.1 - 4.5	6	100			530	740	590	76.2
Silicon[b]	0 - 0	2	100			27.1	30.9	29	2.69
Silver	0.074 - 2	70	5.71	0.0770	2.90	0.170	0.550	0.285	0.237
Sodium	7 - 1,000	72	91.7	120	220	19.5	965	118	152
Strontium	0.056 - 40	72	98.6	0.210	0.210	3.10	77.6	16.3	14.4
Thallium	0.29 - 2	72	5.56	0.200	0.940	0.210	0.320	0.168	0.102
Tin[b]	0.81 - 40	72	12.5	0.830	44	2.50	46.5	3.98	7.99
Titanium[b]	0.084 - 0.09	6	100			66	250	121	66.4
Uranium[b]	1.3 - 1.5	6	16.7	1.30	1.40	1.60	1.60	0.842	0.372
Vanadium	0.44 - 10	72	98.6	0.430	0.430	6.10	91.9	25.0	13.7
Zinc	0.43 - 4	72	90.3	0.430	15.1	3.20	64.5	14.4	10.6

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Non-Detected Concentration	Maximum Non-Detected Concentration	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Organics (ug/kg)									
2-Butanone	10 - 113	45	2.22	9.50	13	4	4	5.22	0.369
Acetone	10 - 113	40	22.5	10	25.3	1	20	6.70	3.61
bis(2-Ethylhexyl)phthalate	10 - 330	55	41.8	340	370	36	100	124	63.1
Chloroform[b]	4.97 - 5.69	54	1.85	0.850	7	96	96	4.11	12.8
Diethylphthalate	10 - 330	55	3.64	340	650	190	240	175	10.2
Di-n-butylphthalate	10 - 330	55	41.8	330	370	39	520	231	111
Methylene chloride	4.97 - 5.69	52	25	1.23	36	1	16	3.45	3.17
Toluene	4.97 - 5.69	54	38.9	1.25	6	1	36	3.73	5.74
Xylene	5 - 11.3	54	1.85	2.48	7	5	5	2.52	0.583
Radionuclides (pCi/g)[c]									
Americium-241	0 - 0.216	63	N/A			-0.0526	0.0628	0.00653	0.0136
Cesium-134	0.02 - 0.02	2	N/A			0.0300	0.0300	0.0300	0
Cesium-137	0.02 - 0.06	4	N/A			0.0342	0.0600	0.0474	0.0146
Gross Alpha	2 - 22.18	9	N/A			8.03	31.3	16.1	8.50
Gross Beta	2.4 - 5.73	10	N/A			4.00	36.6	19.1	10.9
Plutonium-239/240	0 - 0.214	67	N/A			-0.00400	0.690	0.0227	0.0902
Radium-226	0.2 - 0.21	4	N/A			0.579	1.55	1.04	0.459
Radium-228	0.07 - 0.08	4	N/A			0.890	1.35	1.16	0.193
Strontium-89/90	0.03 - 0.7828	6	N/A			-0.0997	0.121	0.0269	0.0750
Uranium-233/234	0.012 - 0.139	67	N/A			0.444	3.20	1.39	0.521
Uranium-235	0 - 0.302	67	N/A			-0.0395	0.181	0.0660	0.0410
Uranium-238	0 - 0.16	67	N/A			0.214	3.10	1.37	0.539

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

[b] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[c] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[d] All radionuclide values are considered detects.

Table 2.1

Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	4,370	0.440	500-1,200	2,500	No
Magnesium	3,700	0.370	80-420	65-110	No
Potassium	4,400	0.440	2,000-3,500	N/A	No
Sodium	131	0.0130	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,774	35,000	Yes	14,300	No	No
Antimony	44.4	3.50	No	--	--	No
Arsenic	**2.41**	**17**	**Yes**	**8.18**	**Yes**	**Yes**
Barium	2,872	199	No	--	--	No
Beryllium	100	1.90	No	--	--	No
Boron	9,477	9.70	No	--	--	No
Cadmium	91.4	1.40	No	--	--	No
Chromium[c]	28.4	26	No	--	--	No
Cobalt	122	11.2	No	--	--	No
Copper	4,443	88.1	No	--	--	No
Iron	33,326	23,700	No	--	--	No
Lead	1,000	82.9	No	--	--	No
Lithium	2,222	19.4	No	--	--	No
Manganese	419	558	Yes	316	No	No
Mercury	32.9	0.0380	No	--	--	No
Molybdenum	555	2.60	No	--	--	No
Nickel	2,222	32	No	--	--	No
Nitrate/Nitrite[d]	177,739	37	No	--	--	No
Selenium	555	0.680	No	--	--	No
Silica	N/A	850	UT	--	--	UT
Silver	555	0.600	No	--	--	No
Strontium	66,652	41.6	No	--	--	No
Thallium	7.78	0.270	No	--	--	No
Tin	66,652	4.90	No	--	--	No
Titanium	169,568	340	No	--	--	No
Uranium	333	2.40	No	--	--	No
Vanadium	111	71	No	--	--	No
Zinc	33,326	70	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	0.430	No	--	--	No
Gross Alpha	N/A	79	UT	--	--	UT
Gross Beta	N/A	69	UT	--	--	UT
Plutonium-239/240	9.80	2.20	No	--	--	No
Radium-226	2.69	1.90	No	--	--	No
Uranium-233/234	25.3	15	No	--	--	No
Uranium-235	1.05	0.460	No	--	--	No
Uranium-238	29.3	13	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

N/A = Not available.
UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).
Bold = Analyte retained for further consideration in the next COC selection step.
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Table 2.3

Statistical Distributions and Comparison to Background for IDEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1-p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**92**	**64**	**NON-PARAMETRIC**	**100**	**WRS**	**7.00E-05**	**Yes**
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	100	4	NORMAL	100	WRS	9.60E-01	No

[a] EU data for background comparison do not include data from background locations.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.4

Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment[a]

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[b] (mg/day)	RDA/RDI/AI[c] (mg/day)	UL[c] (mg/day)	Analyte Retained for PRG Screen?
Calcium	71,900	7.19	500-1,200	2,500	No
Magnesium	5,100	0.51	80-420	65-110	No
Potassium	2,760	0.28	2,000-3,500	N/A	No
Sodium	965	0.10	500-2,400	N/A	No

[a] Sediment greater than 0.5 ft deep was not sampled at the IDEU. Data in this table are for subsurface soil only.

[b] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[c] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

Table 2.5

PRG Screen for Subsurface Soil/Subsurface Sediment[a]

Analyte	PRG[b]	MDC	MDC Exceeds PRG?	UCL[c]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	284,902	52,000	No	--	--	No
Antimony	511	3.3	No	--	--	No
Arsenic	27.7	16	No	--	--	No
Barium	33,033	160	No	--	--	No
Beryllium	1,151	2.1	No	--	--	No
Cesium	N/A	6.6	UT	--	--	UT
Chromium[d]	327	77.5	No	--	--	No
Cobalt	1,401	91.6	No	--	--	No
Copper	51,100	19.7	No	--	--	No
Iron	383,250	30,900	No	--	--	No
Lead	1,000	17.5	No	--	--	No
Lithium	25,550	22	No	--	--	No
Manganese	4,815	885	No	--	--	No
Mercury	379	25.4	No	--	--	No
Molybdenum	6,388	15.6	No	--	--	No
Nickel	25,550	49	No	--	--	No
Nitrate/Nitrite[e]	2.04E+06	2	No	--	--	No
Selenium	6,388	0.59	No	--	--	No
Silica	N/A	740	UT	--	--	UT
Silicon	N/A	30.9	UT	--	--	UT
Silver	6,388	0.55	No	--	--	No
Strontium	766,500	77.6	No	--	--	No
Thallium	89.4	0.32	No	--	--	No
Tin	766,500	46.5	No	--	--	No
Titanium	1.95E+06	250	No	--	--	No
Uranium	3,833	1.6	No	--	--	No
Vanadium	1,278	91.9	No	--	--	No
Zinc	383,250	64.5	No	--	--	No
Organics (ug/kg)						
2-Butanone	5.33E+08	4	No	--	--	No
Acetone	1.15E+09	20	No	--	--	No

Table 2.5

PRG Screen for Subsurface Soil/Subsurface Sediment[a]

Analyte	PRG[b]	MDC	MDC Exceeds PRG?	UCL[c]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
bis(2-Ethylhexyl)phthalate	2.46E+06	100	No	--	--	No
Chloroform	90,270	96	No	--	--	No
Diethylphthalate	7.37E+08	240	No	--	--	No
Di-n-butylphthalate	9.22E+07	520	No	--	--	No
Methylene Chloride	3.13E+06	16	No	--	--	No
Toluene	3.56E+07	36	No	--	--	No
Xylene	1.22E+07	5	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.0628	No	--	--	No
Cesium-134	0.910	0.03	No	--	--	No
Cesium-137	2.54	0.06	No	--	--	No
Gross Alpha	N/A	31.3	UT	--	--	UT
Gross Beta	N/A	36.61	UT	--	--	UT
Plutonium-239/240	112	0.69	No	--	--	No
Radium-226	31	1.55	No	--	--	No
Radium-228	**1.28**	**1.35**	**Yes**	**1.38**	**Yes**	**Yes**
Strontium-89/90	152	0.121	No	--	--	No
Uranium-233/234	291	3.2	No	--	--	No
Uranium-235	12.1	0.1812	No	--	--	No
Uranium-238	337	3.1	No	--	--	No

[a] Sediment greater than 0.5 feet deep bgs was not sampled at the IDEU. Data in this table are for subsurface soil only.

[b] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[c] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[d] The PRG for chromium (VI) is used.

[e] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

Bold = Analyte retained for further consideration in the next COC selection step.

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency >5%[a]	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment - Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Aluminum	Yes	No	--	--	--	--	No
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Manganese	Yes	No	--	--	--	--	No
Subsurface Soil/Subsurface Sediment[b]							
Radium-228	Yes	Yes	N/A	N/A	No	--	No

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.
N/A = Not applicable.

[a] All radionuclide values are considered detects.

[b] Sediment greater than 0.5 feet deep was not sampled at the IDEU. Data in this table are for subsurface soil only.

Table 6.1
Detected PCOCs without PRGs in Each Medium by Analyte Suite[a]

PCOC	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	N/A	X[b]
Silica	X[b]	X[b]
Silicon	N/A	X[b]
Radionuclides		
Gross Alpha	X	X
Gross Beta	X	X

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

X = PRG is unavailable.

N/A = Not applicable. Analyte not detected or not analyzed.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the IDEU

Analyte	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor[a]		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																													
Aluminum	35,000	50	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	**Yes**
Antimony	3.5	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	9.89	No	0.905	**Yes**	18.7	No	57.6	No	138	No	13.2	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Arsenic	17	10	**Yes**	60	No	20	No	164	No	1,030	No	2.57	**Yes**	51.4	No	9.35	**Yes**	13	**Yes**	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Barium	199	500	No	330	No	159	**Yes**	357	No	1,320	No	930	No	4,430	No	3,220	No	4,770	No	24,900	No	19,800	No	18,400	No	N/A	N/A	Mourning Dove Herbivore	**Yes**
Beryllium	1.9	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1,070	No	103	No	29.2	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	9.7	0.5	**Yes**	N/A	N/A	30.3	No	115	No	167	No	62.1	No	422	No	237	No	314	No	929	No	6,070	No	1,820	No	N/A	N/A	Terrestrial Plants	**Yes**
Cadmium	1.4	32	No	140	No	28.1	No	0.705	**Yes**	15	No	59.9	No	1.56	No	198	No	723	No	1,360	No	51.2	No	9.75	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Calcium	4,370	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	26	1	**Yes**	0.4	**Yes**	24.6	**Yes**	1.34	**Yes**	14	**Yes**	281	No	15.9	**Yes**	703	No	1,460	No	4,170	No	250	No	68.5	No	N/A	N/A	Terrestrial Invertebrates	**Yes**
Cobalt	11.2	13	No	N/A	N/A	278	No	87	No	440	No	1,480	No	363	No	2,460	No	7,900	No	3,780	No	2,490	No	1,520	No	N/A	N/A	Terrestrial Plants	No
Copper	88.1	100	No	50	**Yes**	28.9	**Yes**	8.25	**Yes**	164	No	295	No	605	No	838	No	4,120	No	5,460	No	3,000	No	4,640	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Iron	23,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	82.9	110	No	1,700	No	49.9	**Yes**	12.1	**Yes**	95.8	No	1,340	No	242	No	1,850	No	9,800	No	8,930	No	3,070	No	1,390	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Lithium	19.4	2	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,880	No	610	No	3,180	No	10,200	No	18,400	No	5,610	No	2,560	No	N/A	N/A	Terrestrial Plants	**Yes**
Magnesium	3,700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	558	500	**Yes**	N/A	N/A	1,030	No	2,630	No	9,920	No	486	**Yes**	4,080	No	1519	No	2,510	No	14,100	No	10,900	No	19,100	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Mercury	0.038	0.3	No	0.1	No	0.197	No	0.0001	**Yes**	1.57	No	0.439	No	0.179	No	3.15	No	7.56	No	8.18	No	8.49	No	37.3	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Molybdenum	2.6	2	**Yes**	N/A	N/A	44.4	No	6.97	No	76.7	No	8.68	No	1.9	**Yes**	27.1	No	44.3	No	275	No	28.9	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Nickel	32	30	**Yes**	200	No	44.1	No	1.24	**Yes**	13.1	**Yes**	16.4	**Yes**	0.431	**Yes**	38.3	No	124	No	90.9	No	6.02	**Yes**	1.86	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Nitrate / Nitrite	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,480	No	7,650	No	16,200	No	22,700	No	32,900	No	32,200	No	32,900	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	4,400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	0.68	1	No	70	No	1.61	No	1	No	8.48	No	0.872	No	0.754	No	2.8	No	3.82	No	32.5	No	12.2	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	No
Silicon	850	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silver	0.6	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	No
Sodium	131	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	41.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,600	No	3,520	No	4,700	No	584,000	No	145,000	No	57,300	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	0.27	1	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,040	No	212	No	81.6	No	30.8	No	N/A	N/A	Terrestrial Plants	No
Tin	4.9	50	No	N/A	N/A	26.1	No	2.9	**Yes**	19	No	45	No	3.77	**Yes**	80.6	No	242	No	70	No	36.1	No	16.2	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Titanium	340	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Uranium	2.4	5	No	N/A	N/A	685	No	446	No	2,790	No	970	No	569	No	1,230	No	5,470	No	7,300	No	3,110	No	2,270	No	N/A	N/A	Terrestrial Plants	No
Vanadium	71	2	**Yes**	N/A	N/A	503	No	274	No	1,510	No	63.7	**Yes**	29.9	**Yes**	83.5	No	358	No	341	No	164	No	121	No	N/A	N/A	Terrestrial Plants	**Yes**
Zinc	70	50	**Yes**	200	No	109	No	0.646	**Yes**	113	No	171	No	5.29	**Yes**	1,170	No	2,770	No	16,500	No	3,890	No	431	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Radionuclides (pCi/g)																													
Americium-241	0.43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	No	N/A	No
Gross Alpha	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Gross Beta	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-239/240	2.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	N/A	No
Uranium-233/234	4.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	N/A	No
Uranium-235	0.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	N/A	No
Uranium-238	4.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	N/A	No

a Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.
b The ESLs for chromium were devleoped based on available toxicity data and are based on chromium III (birds) and chromium VI (plants, invertebrates and mammals).
N/A = Indicates no ESL was available for that ECOI/receptor pair.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further screening in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the IDEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Antimony	No	No	**Yes**
Arsenic	**Yes**	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	**Yes**
Calcium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	No
Copper	No	**Yes**	**Yes**
Iron	UT	UT	UT
Lead	No	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	No	No	**Yes**
Molybdenum	**Yes**	UT	**Yes**
Nickel	**Yes**	No	**Yes**
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	No	No	No
Silicon	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	No	UT	No
Tin	No	UT	**Yes**
Titanium	UT	UT	UT
Uranium	No	UT	No
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Radionuclides			
Americium-241	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
Plutonium-239/240	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3
Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM in the IDEU

Analyte	MDC	PMJM NOAEL ESL	EPC> PMJM ESL?
Inorganics (mg/kg)			
Aluminum	12,100	N/A	UT
Arsenic	**7.6**	**2.21**	**Yes**
Barium	132	743	No
Beryllium	0.74	8.16	No
Boron	5.0	52.7	No
Cadmium	0.85	1.75	No
Calcium	6,960	N/A	UT
Chromium[a]	15.8	19.3	No
Cobalt	10.8	340	No
Copper	38.0	95.0	No
Iron	25,900	N/A	UT
Lead	41.60	220	No
Lithium	12.4	519	No
Magnesium	6,490	N/A	UT
Manganese	**556**	**388**	**Yes**
Mercury	0.0038	0.052	No
Molybdenum	0.42	1.84	No
Nickel	**10.70**	**0.51**	**Yes**
Nitrate / Nitrite	26.00	2,910	No
Potassium	4,730	N/A	UT
Selenium	**0.58**	**0.421**	**Yes**
Silica	833	N/A	UT
Sodium	6,510	N/A	UT
Strontium	35.10	833	No
Titanium	433	N/A	UT
Vanadium	**42.0**	**21.6**	**Yes**
Zinc	**138**	**6.41**	**Yes**
Organics (µg/kg)			
Benzoic acid	180	N/A	UT
Radionuclides (pCi/kg)			
Americium-241	0.025	3,890	No
Plutonium-239/240	0.11	6,110	No
Uranium-233/234	2.1	4,980	No
Uranium-235	0.077	2,770	No
Uranium-238	2.00	1,580	No

[a] Chromium ESL is based on Chromium VI.

N/A = No ESL Available.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4
Statistical Distribution and Comparison to Background for Surface Soil in the IDEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Aluminum	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	4.81E-03	**Yes**
Antimony	20	NON-PARAMETRIC	0	64	NON-PARAMETRIC	14	N/A	N/A	**Yes**[a]
Arsenic	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	7.40E-04	**Yes**
Barium	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	3.65E-05	**Yes**
Boron	N/A	N/A	N/A	14	NORMAL	79	N/A	N/A	**Yes**[a]
Cadmium	20	NON-PARAMETRIC	65	64	NON-PARAMETRIC	42	WRS	0.959	No
Chromium	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	7.62E-03	**Yes**
Copper	20	NON-PARAMETRIC	100	64	NON-PARAMETRIC	100	WRS	0.978	No
Lead	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	1.03E-02	**Yes**
Lithium	20	NORMAL	100	64	GAMMA	100	WRS	1.88E-04	**Yes**
Manganese	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	4.03E-04	**Yes**
Mercury	20	NON-PARAMETRIC	40	64	NON-PARAMETRIC	22	WRS	0.998	No
Molybdenum	20	NORMAL	0	64	NON-PARAMETRIC	38	N/A	N/A	**Yes**[a]
Nickel	20	NORMAL	100	64	LOGNORMAL	100	WRS	0.759	No
Tin	20	NORMAL	0	64	NON-PARAMETRIC	22	N/A	N/A	**Yes**[a]
Vanadium	20	NORMAL	100	64	NON-PARAMETRIC	100	WRS	1.23E-01	No
Zinc	20	NORMAL	100	64	GAMMA	100	WRS	0.998	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable; background data not available or not detected.

WRS = Wilcoxon Rank Sum.

Table 7.5
Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the IDEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics									
Arsenic	20	NORMAL	100	7	GAMMA	100	WRS	0.925	No
Manganese	20	NORMAL	100	7	NORMAL	100	t-Test N	0.203	No
Nickel	20	NORMAL	100	7	NORMAL	100	t-Test N	0.898	No
Selenium	20	NON-PARAMETRIC	60	7	NORMAL	43	WRS	0.994	No
Vanadium	20	NORMAL	100	7	NORMAL	100	t-Test N	0.621	No
Zinc	20	NORMAL	100	7	LOGNORMAL	100	WRS	0.988	No

WRS = Wilcoxon Rank Sum.
t-Test_N = Student's t-test using normal data.

Table 7.6
Statistical Concentrations in Surface Soil in the IDEU

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean	Median	75th percentile	95th percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Aluminum	64	95% Student's-t UCL	NON-PARAMETRIC	13,234	11,800	15,450	19,340	14,309	19,400	35,000
Antimony	64	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.4	1.4	1.5	3.1	1.9	3.1	4.9
Arsenic	64	95% Student's-t UCL	NON-PARAMETRIC	7.8	7.4	8.4	11.6	8.2	12	17
Barium	64	95% Student's-t UCL	NON-PARAMETRIC	124	124	131	153	128	153	199
Boron	14	95% Student's-t UCL	NORMAL	5.6	5.8	6.6	9.1	6.7	10.3	9.7
Chromium	64	95% Student's-t UCL	NON-PARAMETRIC	13.7	12.5	15.2	22.3	14.5	22.7	26
Lead	64	95% Student's-t UCL	NON-PARAMETRIC	39.9	41.5	44.5	61.8	42.7	62.8	82.9
Lithium	64	95% Approximate Gamma UCL	GAMMA	10.2	9.5	11.7	15.8	10.8	16	19.4
Manganese	64	95% Student's-t UCL	NON-PARAMETRIC	300	291	332	430	316	430	558
Molybdenum	64	95% Student's-t UCL	NON-PARAMETRIC	0.8	0.7	0.8	1.5	0.9	1.5	2.6
Tin	64	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.8	1.4	2.4	4	2.4	4.1	4.9

MDC = maximum proxy result; may be MDC or reporting limit greater than MDC.
UCL = 95% upper confidence limit on the mean, unless the MDC is less than the UCL then the MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC is less than the UCL then the MDC is used as the UCL.

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the IDEU

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (UTL)	Limiting ESL[a]	EPC>ESL?	EPC (UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	19,400	50	**Yes**	14,309	N/A	N/A
Antimony	3.1	0.905	**Yes**	1.9	3.85	No
Arsenic	12	2.57	**Yes**	8.2	13	No
Barium	153	159	No	128	4,770	No
Boron	9.7	0.5	**Yes**	6.7	314	No
Chromium	22.7	0.4	**Yes**	14.5	68.5	No
Lead	62.8	49.9	**Yes**	42.7	1,390	No
Lithium	16	2	**Yes**	10.8	2,560	No
Manganese	430	486	No	316	2,510	No
Molybdenum	1.5	1.9	No	0.9	8.18	No
Tin	4.1	2.9	**Yes**	2.4	16.2	No

[a]Lowest ESL (threshold if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

[b]Lowest ESL (threshold if available) for the coyote and mule deer receptors.

N/A = Not applicable; ESL not available.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.8
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home-Range Receptors in the IDEU

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	19,400	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	3.1	5	78	N/A	N/A	N/A	9.89	**0.905**	18.7
Arsenic	12	**10**	60	1,030	20	164	**2.57**	51.4	**9.35**
Boron	10.3	**0.5**	N/A	167	30.3	115	62.1	422	237
Chromium	22.7	**1**	**0.4**	**14**	24.6	**1.34**	281	**15.9**	703
Lead	62.8	110	1700	95.8	**49.9**	**12.1**	1,340	242	1,850
Lithium	16	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Tin	4.1	50	N/A	19	26.1	**2.9**	45	**3.77**	80.6

[a]Lowest ESL (threshold if available) for that receptor.
N/A = Not applicable; ESL not available.
Bold = Receptors of potential concern.

Table 7.9
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors in the IDEU

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Deer mouse (insectivore)**
Arsenic	Yes	Yes	Yes	Yes	No	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	No	--	--	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (herbivore)** **Mourning dove (insectivore)**
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	Yes	Yes	Yes	No	--	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	Yes	Yes	N/A	No	--	No	--
Nickel	Yes	Yes	No	--	--	No	--
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	No	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	No	--	--	--	--	No	--
Tin	Yes	Yes	N/A	Yes	No	No	--
Titanium	UT	--	--	--	--	No	--
Uranium	No	--	--	--	--	No	--
Vanadium	Yes	Yes	No	--	--	No	--
Zinc	Yes	Yes	No	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.

N/A = Not applicable.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Chemicals retained as ECOPCs for further risk characterization.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the IDEU

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background?	Professional Judgment - Retain?	ECOPC?
Inorganics				
Aluminum	UT	--	--	No
Arsenic	**Yes**	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Chromium	No	--	--	No
Cobalt	No	--	--	No
Copper	No	--	--	No
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	**Yes**	No	--	No
Mercury	No	--	--	No
Molybdenum	No	--	--	No
Nickel	**Yes**	No	--	No
Nitrate / Nitrite	No	--	--	No
Potassium	UT	--	--	No
Selenium	**Yes**	No	--	No
Silica	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Titanium	UT	--	--	No
Vanadium	**Yes**	No	--	No
Zinc	**Yes**	No	--	No
Organics				
Benzoic acid	UT	--	--	No
Radionuclides				
Americium-241	No	--	--	No
Plutonium-239/240	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

-- = Screen not performed because ECOI did not pass the previous screen.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.11
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for Burrowing Receptors in the IDEU

Analyte	MDC	Prairie Dog NOAEL ESL[a]	MDC > ESL?
Inorganics (mg/kg)			
Aluminum	52,000	N/A	UT
Antimony	3.3	18.7	No
Arsenic	**16**	**9.35**	**Yes**
Barium	160	3,220	No
Beryllium	2.1	211	No
Calcium	71,900	N/A	UT
Cesium	6.6	N/A	UT
Chromium[a]	77.5	703	No
Cobalt	91.6	2,460	No
Copper	19.7	838	No
Iron	30,900	N/A	UT
Lead	17.5	1,850	No
Lithium	22	3,180	No
Magnesium	5,100	N/A	UT
Manganese	885	1,519	No
Mercury	**25.4**	**3.15**	**Yes**
Molybdenum	15.6	27.1	No
Nickel	**49**	**38.3**	**Yes**
Nitrate / Nitrite	2	16,200	No
Potassium	2,760	N/A	UT
Selenium	0.59	2.8	No
Silica	740	N/A	UT
Silicon	30.9	N/A	UT
Silver	0.55	N/A	UT
Sodium	965	N/A	UT
Strontium	77.6	3,520	No
Thallium	0.32	204	No
Tin	46.5	80.6	No
Titanium	250	N/A	UT
Uranium	1.6	1,230	No
Vanadium	**91.9**	**83.5**	**Yes**
Zinc	64.5	1,170	No
Organics (µg/kg)			
2-Butanone	4	49,400,000	No
Acetone	20	248,000	No
bis(2-ethylhexyl)phthalate	100	2,760,000	No
Chloroform	96	560,000	No
Diethylphthalate	240	221,000,000	No
Di-n-butylphthalate	520	40,600,000	No
Methylene Chloride	16	210,000	No
Toluene	36	1,220,000	No
Xylene	5	112,000	No
Radionuclides (pCi/g)			
Americium-241	0.0628	3,890	No
Cesium-134	0.03	N/A	UT
Cesium-137	0.06	20.8	No
Gross Alpha	31.3	N/A	UT
Gross Beta	36.61	N/A	UT
Plutonium-239/240	0.69	6,110	No
Radium-226	1.55	50.6	No
Radium-228	1.35	43.9	No
Strontium-89/90	0.121	22.5	No
Uranium-233/234	3.2	4,980	No
Uranium-235	0.1812	2,770	No
Uranium-238	3.1	1,580	No

[a] Chromium ESL is based on Chromium VI.

N/A = No ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.12
Statistical Distribution and Comparison to Background for Subsurface Soil in the IDEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Arsenic	45	NON-PARAMETRIC	93	72	GAMMA	100	WRS	0.544	No
Mercury	41	NON-PARAMETRIC	29	72	NON-PARAMETRIC	19.4	N/A	N/A	**Yes**[a]
Nickel	44	GAMMA	100	72	GAMMA	85	WRS	1.000	No
Vanadium	45	NORMAL	98	72	NON-PARAMETRIC	99	WRS	1.000	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable; background data not available or not detected.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.13

Statistical Concentrations in Subsurface Soil in the IDEU

Analyte	Units	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean	Median	75th percentile	95th percentile	UCL	UTL	MDC
Mercury	mg/kg	72	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	0.413	0.050	0.055	0.134	1.95	0.15	25.4

MDC = maximum proxy result; may be MDC or reporting limit greater than MDC.

UCL = 95% upper confidence limit on the mean, unless the MDC is less than the UCL then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC is less than the UCL then the MDC is used as the UCL.

Table 7.14
Upper-Bound Exposure Point Concentration Comparison to tESLs in the IDEU

Analyte	Burrowing Receptors		
	EPC (UTL)	tESL[a]	EPC>tESL?
Inorganics (mg/kg)			
Mercury	0.15	3.15	No

[a]Threshold ESL (if available) for the prairie dog receptor.

Table 7.15
Summary of ECOPC Screening Steps for Subsurface Soil in the IDEU

Analyte	Exceed Prairie Dog NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Antimony	No	--	--	--	--	No
Arsenic	Yes	Yes	No	--	--	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	Yes	Yes	N/A	No	--	No
Molybdenum	No	--	--	--	--	No
Nickel	Yes	Yes	No	--	--	No
Nitrate / Nitrite	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	Yes	Yes	No	--	--	No
Zinc	No	--	--	--	--	No
Organics (µg/kg)						
2-Butanone	No	--	--	--	--	No
Acetone	No	--	--	--	--	No
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No
Chloroform	No	--	--	--	--	No
Diethylphthalate	No	--	--	--	--	No
Di-n-butylphthalate	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Xylene	No	--	--	--	--	No
Radionuclides (pCi/g)						
Americium-241	No	--	--	--	--	No
Cesium-134	UT	--	--	--	--	No
Cesium-137	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Radium-226	No	--	--	--	--	No
Radium-228	No	--	--	--	--	No
Strontium-89/90	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.

'-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

N/A = Not applicable; background comparison could not be conducted.

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

Table 8.1
Summary of ECOPC/Receptor Pairs

ECOPC	Receptors of Potential Concern
Surface Soil - Non-PMJM	
Antimony	Deer mouse (insectivore)
Lead	Mourning dove (herbivore) Mourning dove (insectivore)
Surface Soil - PMJM	
None	None
Subsurface Soil	
None	None

Table 8.2
Surface Soil Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	Tier 1 Exposure Point Concentrations		Tier 2 Exposure Point Concentrations	
	UTL	UCL	UTL	UCL
Inorganics (mg/kg)				
Antimony	3.1	1.9	9.83	6.18
Lead	62.8	42.7	48.4	37.6

Table 8.3
Surface Water Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	MDC	UTL	UCL	Mean
Inorganics (mg/L)				
Antimony	0.025	0.028	0.017	0.013
Lead	0.037	0.037	0.022	0.01

Table 8.4
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day^{-1})	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day^{-1})	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Vertebrate Receptors - Birds												
Mourning Dove (herbivore)	0.113	Average of adult values from CalEPA (2004) Online Database	100	0	0	Cowan (1952)	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Mourning Dove (insectivore)	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Vertebrate Receptors - Mammals												
Deer Mouse (insectivore)	0.0187	Flake (1973)	0	100	0	Generalized Diet	0.065	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in USEPA 1993.	2	Beyer et al. (1994)

All receptor parameters are estimates of central tendency except where noted.

All values are presented in a dry weight basis.

N/A = Not applicable.

Table 8.5
Receptor Specific Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Antimony						
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.202	N/A	0.00403	0.00532	0.211
Tier 2 UTL	N/A	0.639	N/A	0.0128	0.00532	0.657
Lead						
Mourning Dove - Herbivore						
Tier 1 UTL	0.622	N/A	N/A	1.34	0.00444	1.97
Tier 2 UTL	0.537	N/A	N/A	1.04	0.00444	1.58
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	5.22	N/A	1.34	0.00444	6.57
Tier 2 UTL	N/A	4.23	N/A	1.04	0.00444	5.27

N/A = Not applicable.

Table 9.1
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Birds										
Lead	1.63	No change in chicken reproduction	1.94	Decrease in Japanese quail reproduction	EPA (2003)	1	1.63	N/A	No threshold value calculated because the study was not reviewed and effect levels are unknown.	Very High
Mammals										
Antimony	0.06	No change to rat progeny weight	0.59	Decrease in rat progeny weight	EPA (2003)	1	0.06	N/A	The original paper was not reviewed. Not enough information was available to calculate the threshold TRV	Very High

Threshold TRVs were independently calculated using the procedures outlined in the CRA Methodology, Section 3.1.4.
TRV Confidence:
N/A = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.
Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.
Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.
Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.
High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.
Very High = All EcoSSLs (EPA 2003) will be assigned this level of confidence by default.

Table 10.1

Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
Antimony	Deer Mouse (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 4 ***LOAEL*** UTL = 0.4	Not calculated
			Tier 2	***NOAEL*** UTL = 11 ***LOAEL*** UTL = 1	Not calculated
		Median	Tier 1	Not calculated	Not calculated
			Tier 2	Not calculated	Not calculated
Lead	Mourning Dove (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 1	Not calculated
			Tier 2	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.9	Not calculated
		Median	Tier 1	Not calculated	Not calculated
			Tier 2	Not calculated	Not calculated
	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 4 ***LOAEL*** UTL = 3	Not calculated
			Tier 2	***NOAEL*** UTL = 3 ***LOAEL*** UTL = 3	Not calculated
		Median	Tier 1	Not calculated	Not calculated
			Tier 2	Not calculated	Not calculated

Shaded cells designate HQs that were calculated using default BAFs and default TRVs, as provided in the CRA Methodology (DOE 2005).

All HQ calculations are provided in Attachment 4.

Discussions of the chemical-specific uncertainties are provided in Attachment 5.

Table 10.2
Tier 2 Grid Cell Hazard Quotients for Surface Soil in IDEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means											
			NOAEL TRV				Threshold TRV				LOAEL TRV			
			HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10
Antimony	Deer Mouse - Insectivore	41	68	27	0	5	N/A	N/A	N/A	N/A	100	0	0	0
Lead	Mourning Dove - Insectivore	41	2	95	0	2	N/A	N/A	N/A	N/A	7	90	2	0

N/A = No value available

The limiting receptor is chosen as the receptor with the lowest ESL.

Default exposure model and TRVs used.

Table 11.1
Summary of Risk Characterization Results for the IDEU

Analyte	Ecological Receptors	Result of Risk Characterization	Chemical-Specific Risk Description Conclusion
Surface Soil Non-PMJM Receptors			
Antimony	Terrestrial plants	Not an ECOPC.	Not an ECOPC
	Terrestrial invertebrate	Not an ECOPC.	Not an ECOPC
	American kestrel	Not an ECOPC.[a]	ECOPC of Uncertain Risk
	Mourning dove (herbivore)	Not an ECOPC.[a]	ECOPC of Uncertain Risk
	Mourning dove (insectivore)	Not an ECOPC.[a]	ECOPC of Uncertain Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs > 1 using default exposure scenarios. LOAEL HQs <= 1 for default exposure scenarios.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Lead	Terrestrial plants	Not an ECOPC.	Low Risk
	Terrestrial invertebrate	Not an ECOPC.	Not an ECOPC
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	NOAEL HQ < = 1 using default exposure scenarios LOAEL HQs < = 1 using default exposure scenarios.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs > 1 using default exposure scenarios. LOAEL HQs > 1 using default exposure scenarios. Background risks similar to IDEU risks.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Surface Soil - PMJM Receptors			
None	Preble's meadow jumping mouse	No ECOPCs.	No ECOPCs
Subsurface Soil			
None	Prairie dog	No ECOPCs.	No ECOPCs

[a]ESL was not available. Analyte evaluated in Section 10.
If an ECOI was not identified as an ECOPC, no risk is predicted.

FIGURES

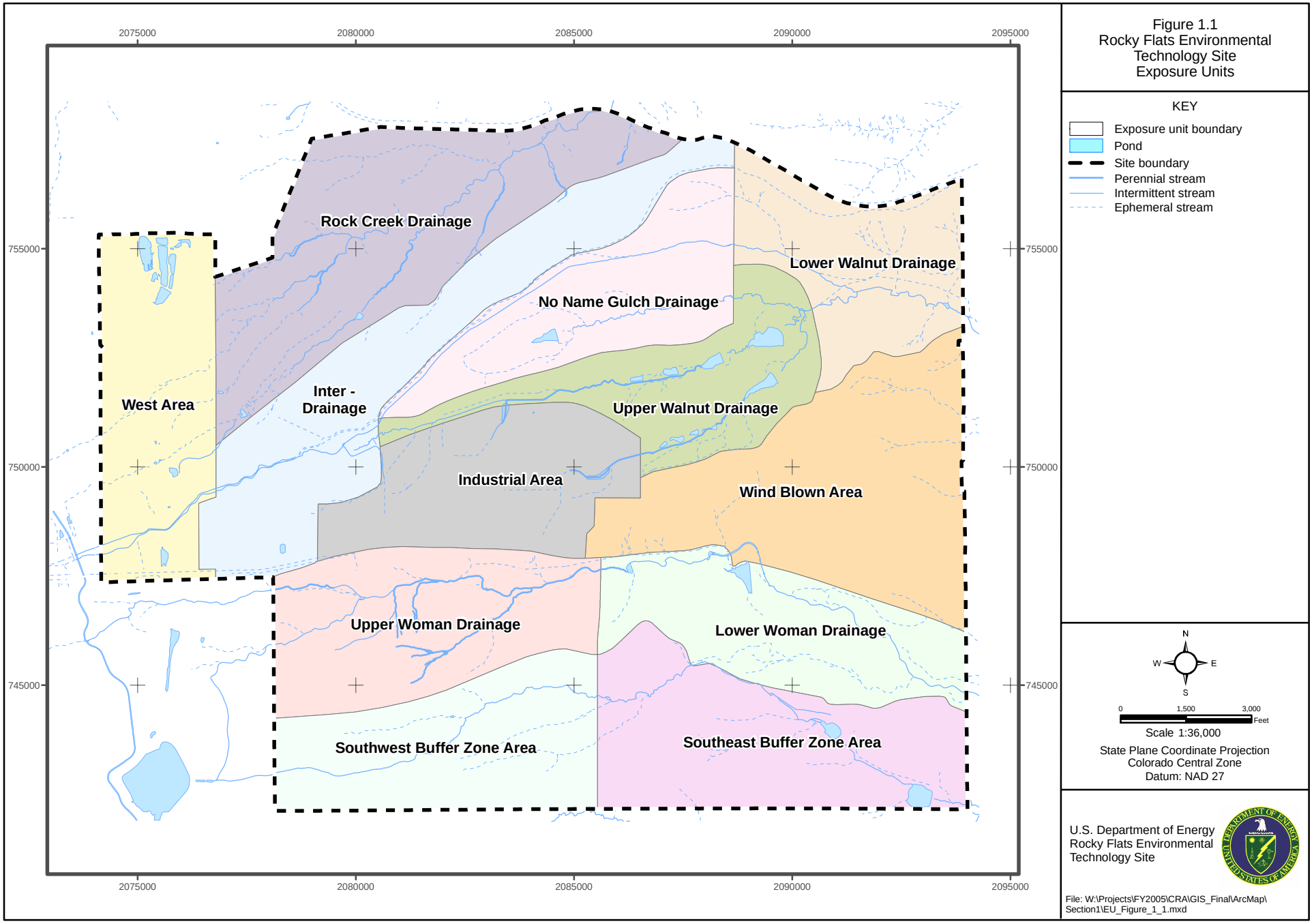

Figure 1.1
Rocky Flats Environmental
Technology Site
Exposure Units

KEY

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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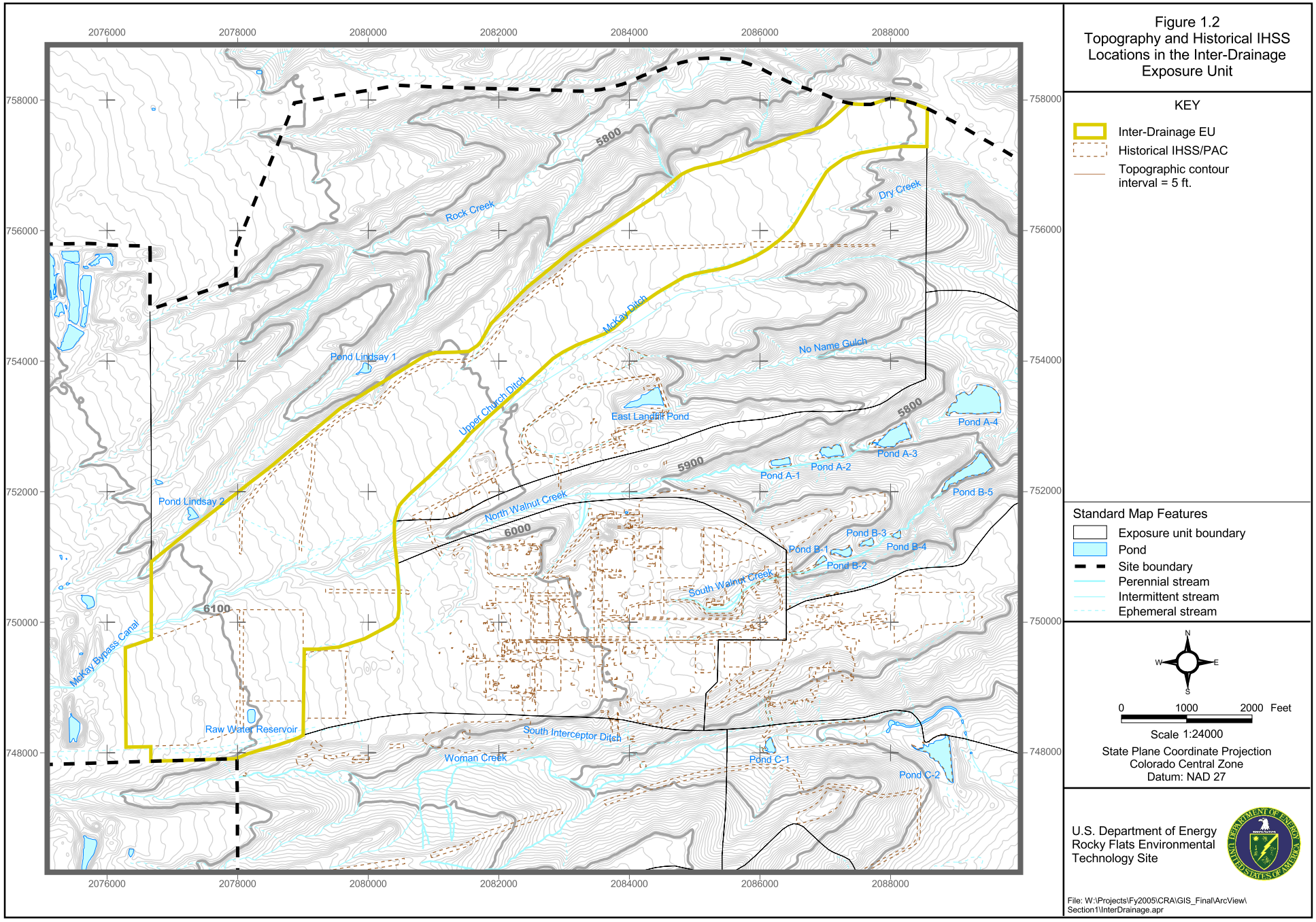

Figure 1.2
Topography and Historical IHSS Locations in the Inter-Drainage Exposure Unit

KEY

- Inter-Drainage EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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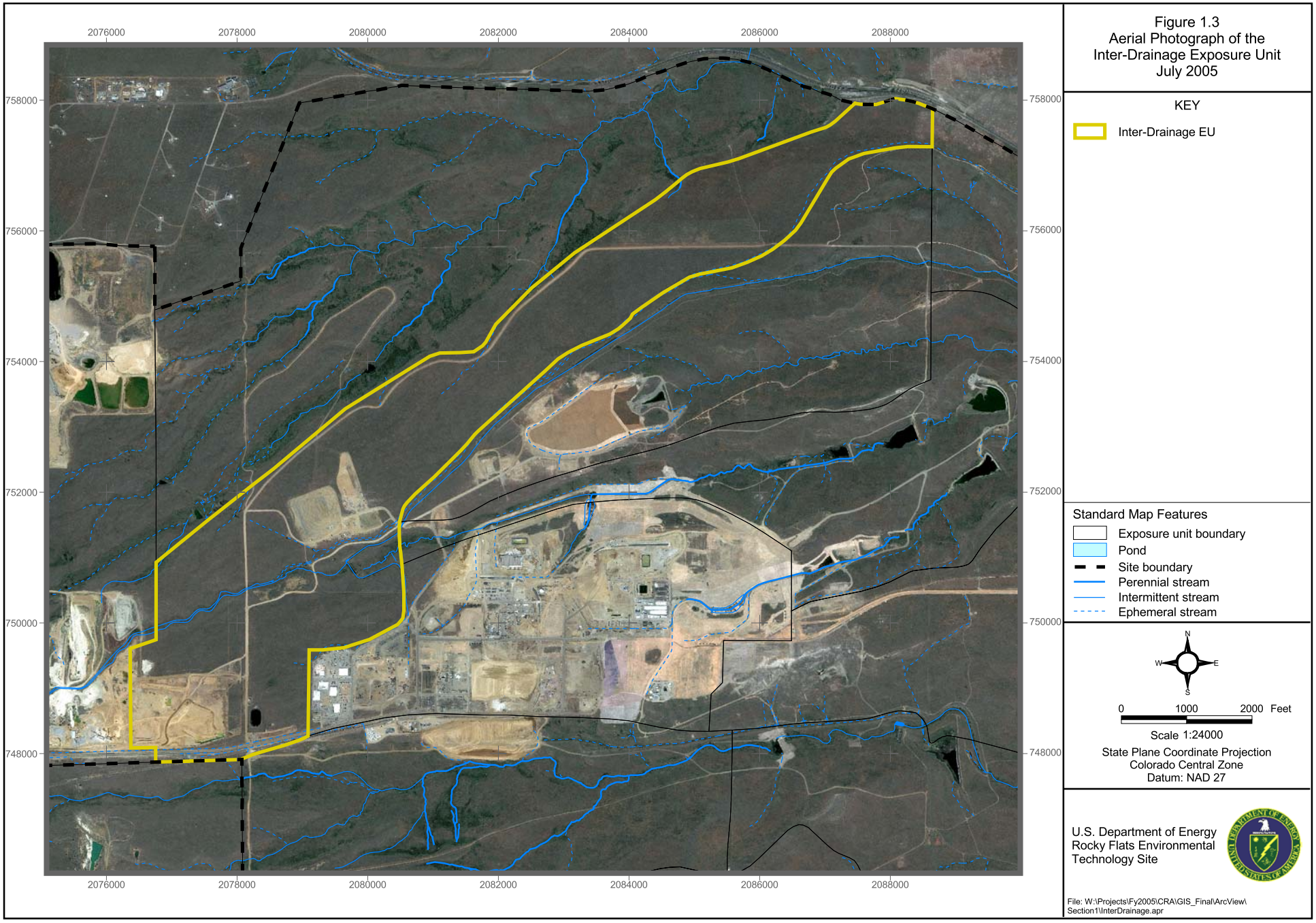

Figure 1.3
Aerial Photograph of the
Inter-Drainage Exposure Unit
July 2005

KEY

Inter-Drainage EU

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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Technology Site

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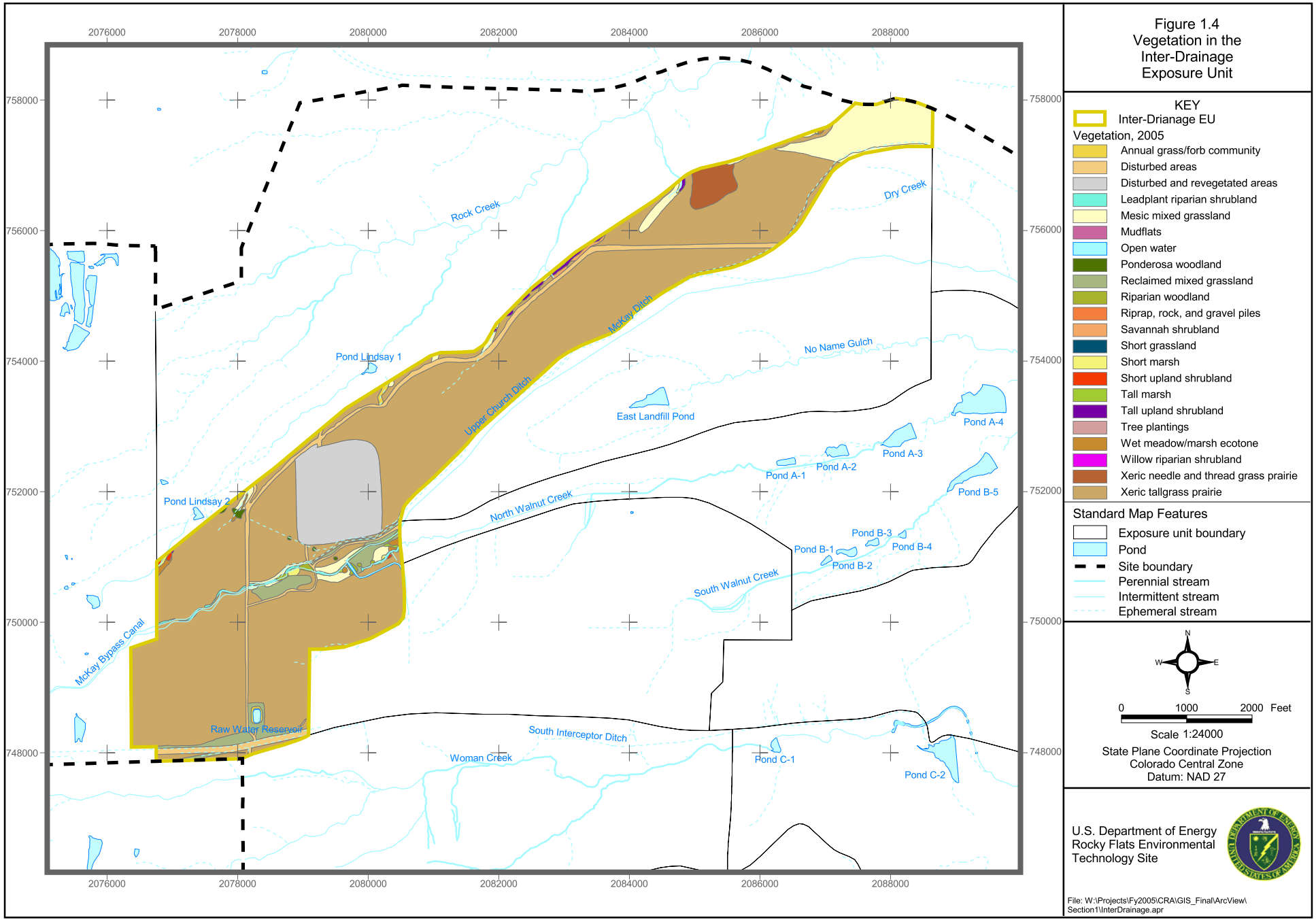

Figure 1.4
Vegetation in the
Inter-Drainage
Exposure Unit

KEY

Inter-Drianage EU

Vegetation, 2005

- Annual grass/forb community
- Disturbed areas
- Disturbed and revegetated areas
- Leadplant riparian shrubland
- Mesic mixed grassland
- Mudflats
- Open water
- Ponderosa woodland
- Reclaimed mixed grassland
- Riparian woodland
- Riprap, rock, and gravel piles
- Savannah shrubland
- Short grassland
- Short marsh
- Short upland shrubland
- Tall marsh
- Tall upland shrubland
- Tree plantings
- Wet meadow/marsh ecotone
- Willow riparian shrubland
- Xeric needle and thread grass prairie
- Xeric tallgrass prairie

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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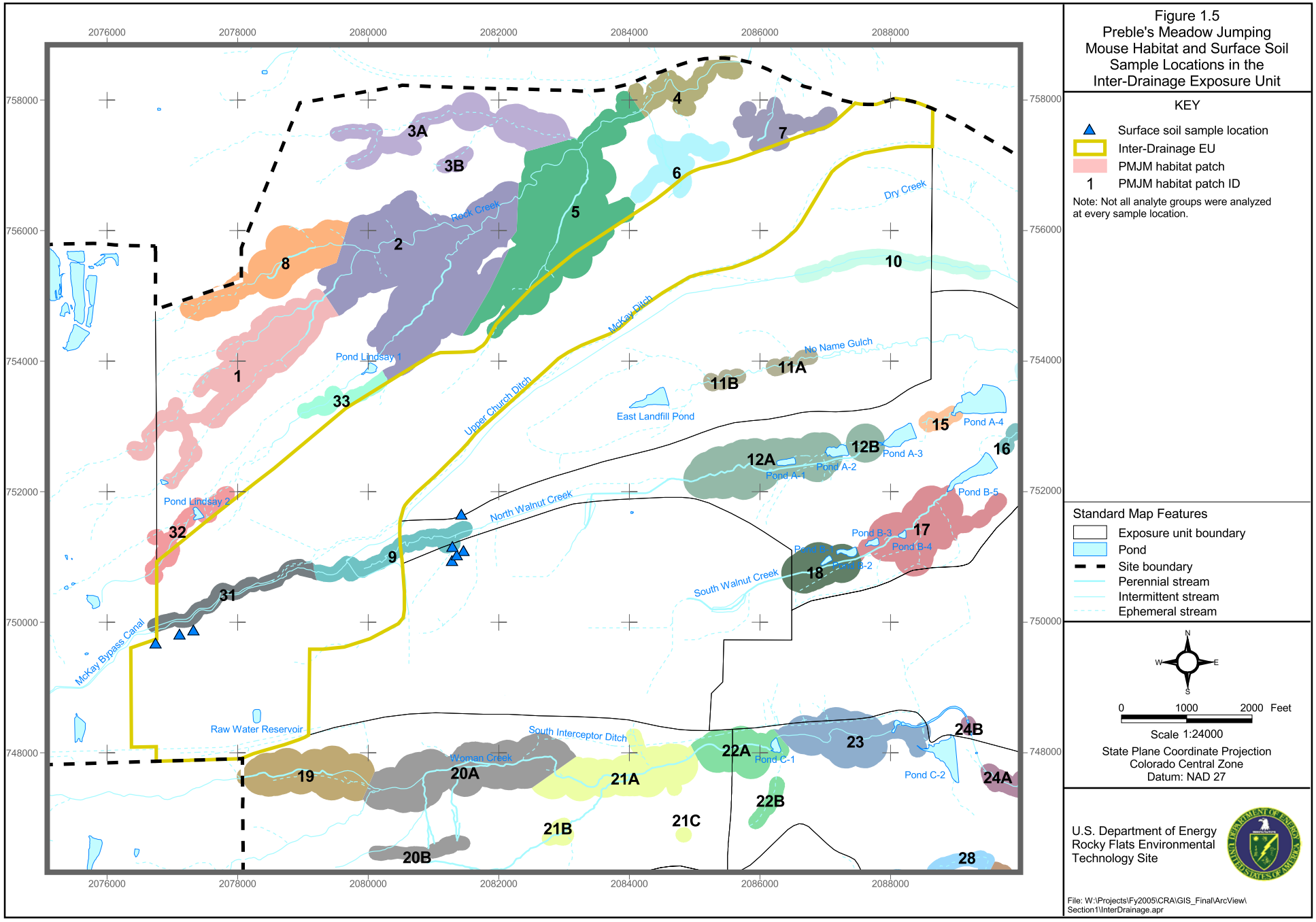

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Inter-Drainage Exposure Unit

KEY

- Surface soil sample location
- Inter-Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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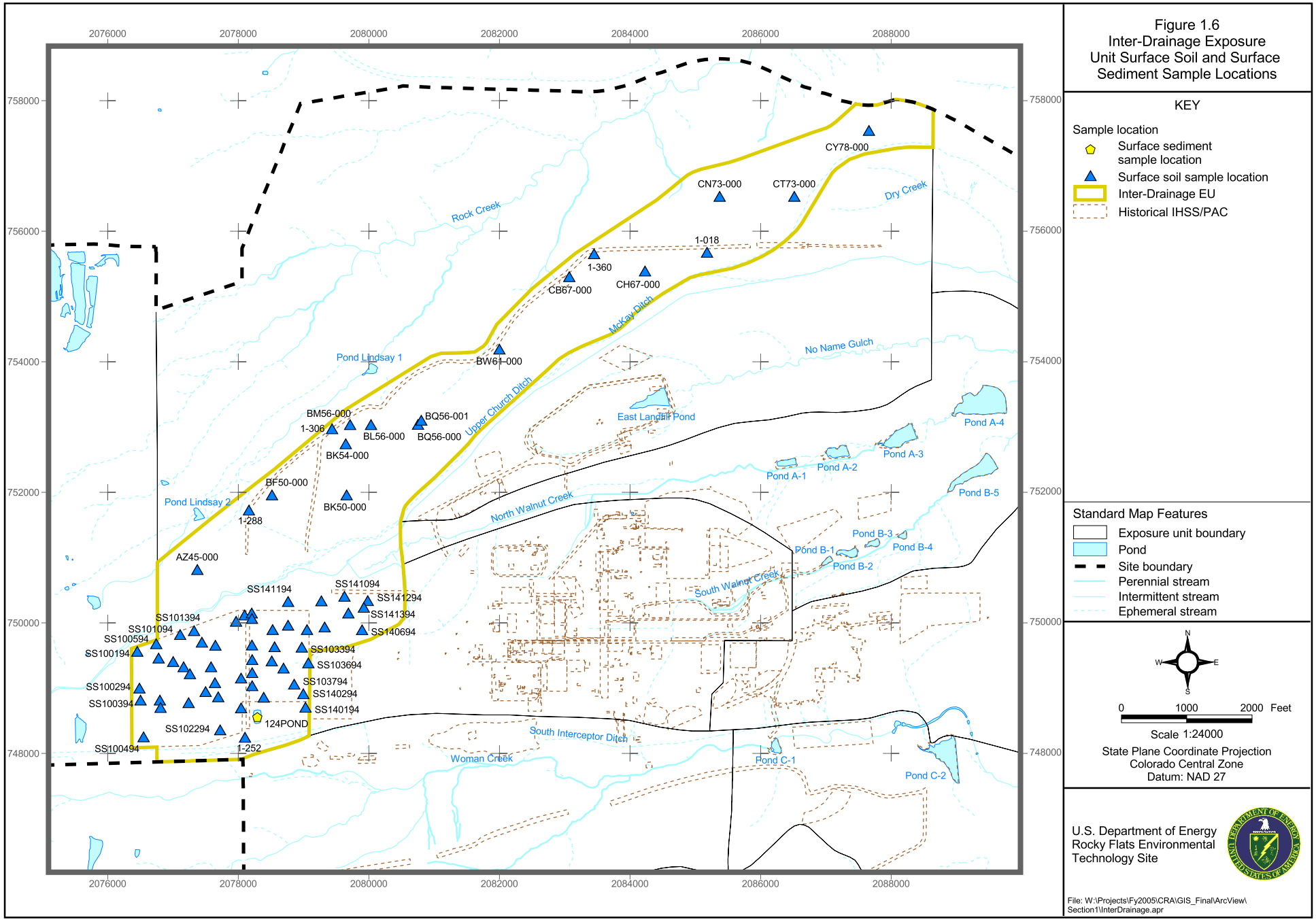

Figure 1.6
Inter-Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location
- Inter-Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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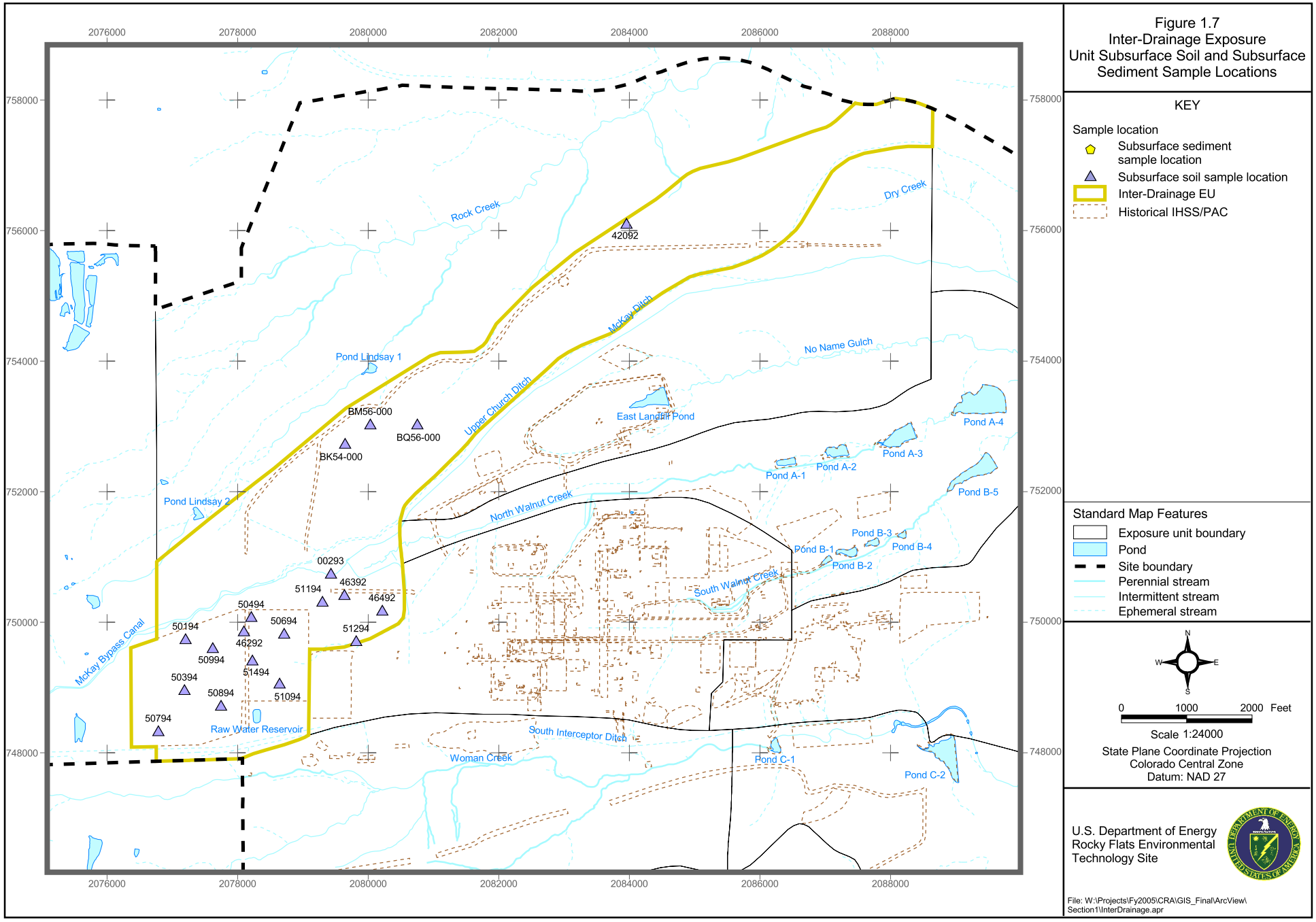

Figure 1.7
Inter-Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location
- Inter-Drainage EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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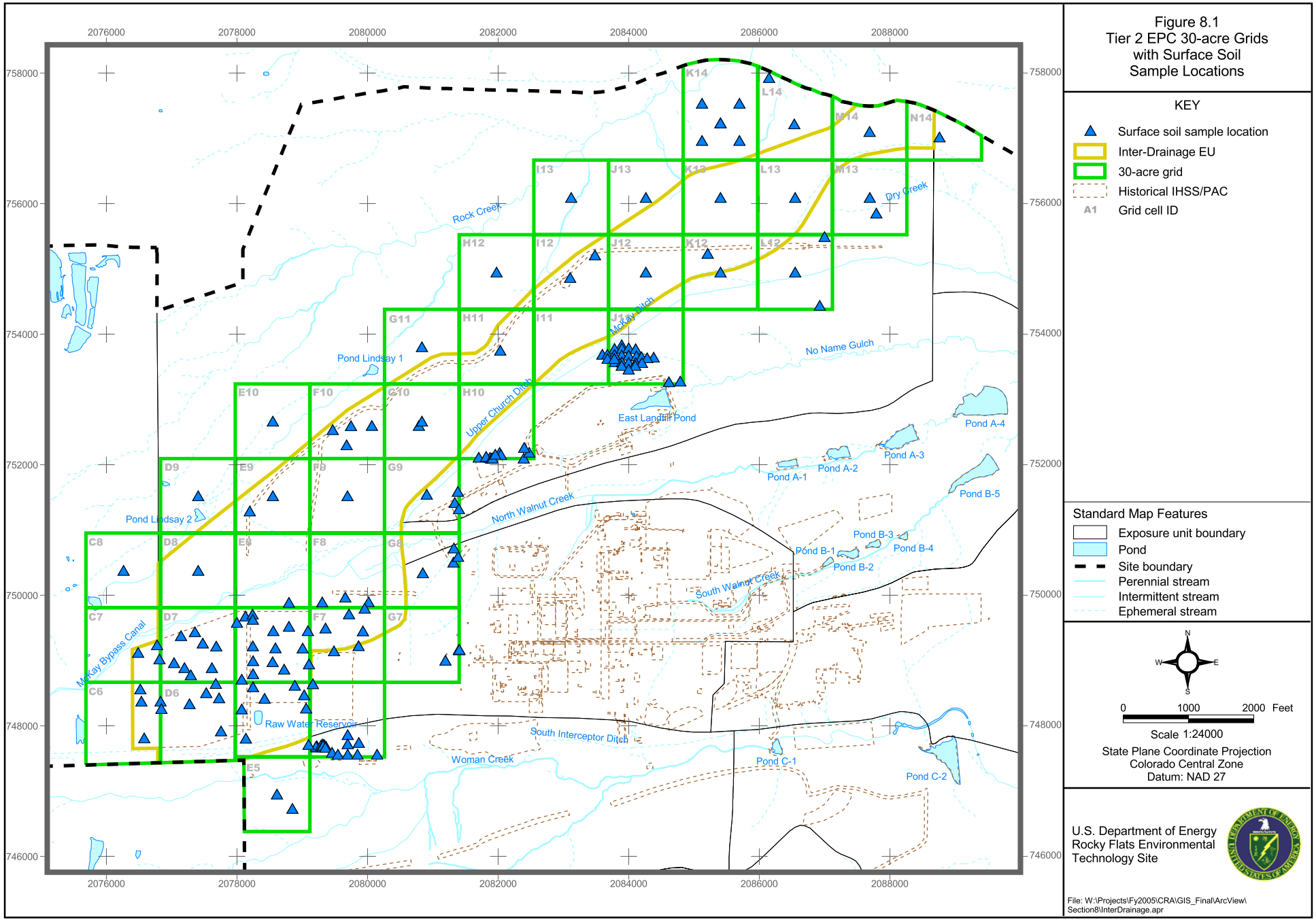

Figure 8.1
Tier 2 EPC 30-acre Grids with Surface Soil Sample Locations

KEY

- Surface soil sample location
- Inter-Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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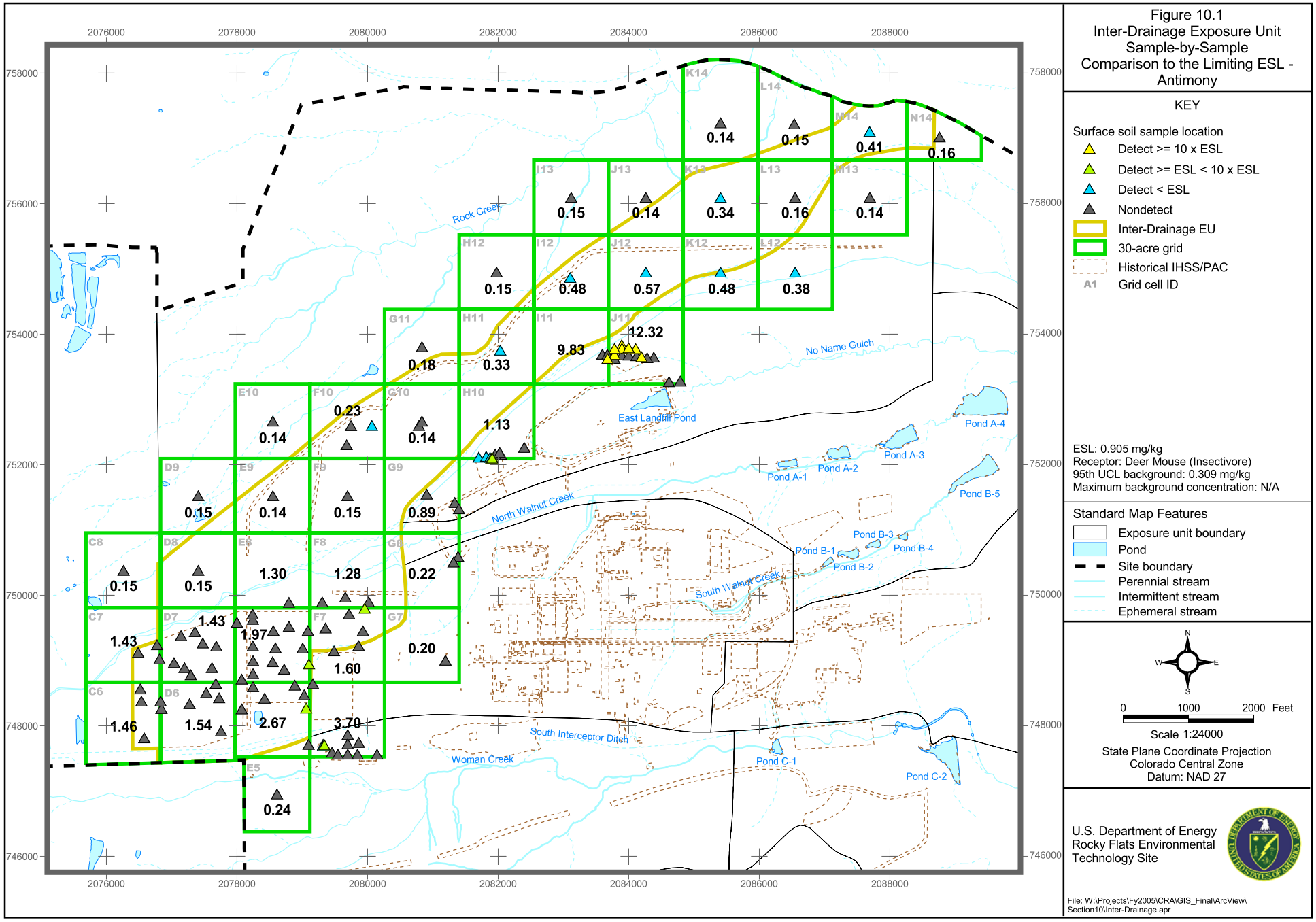

Figure 10.1
Inter-Drainage Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Antimony

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Inter-Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 0.905 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 0.309 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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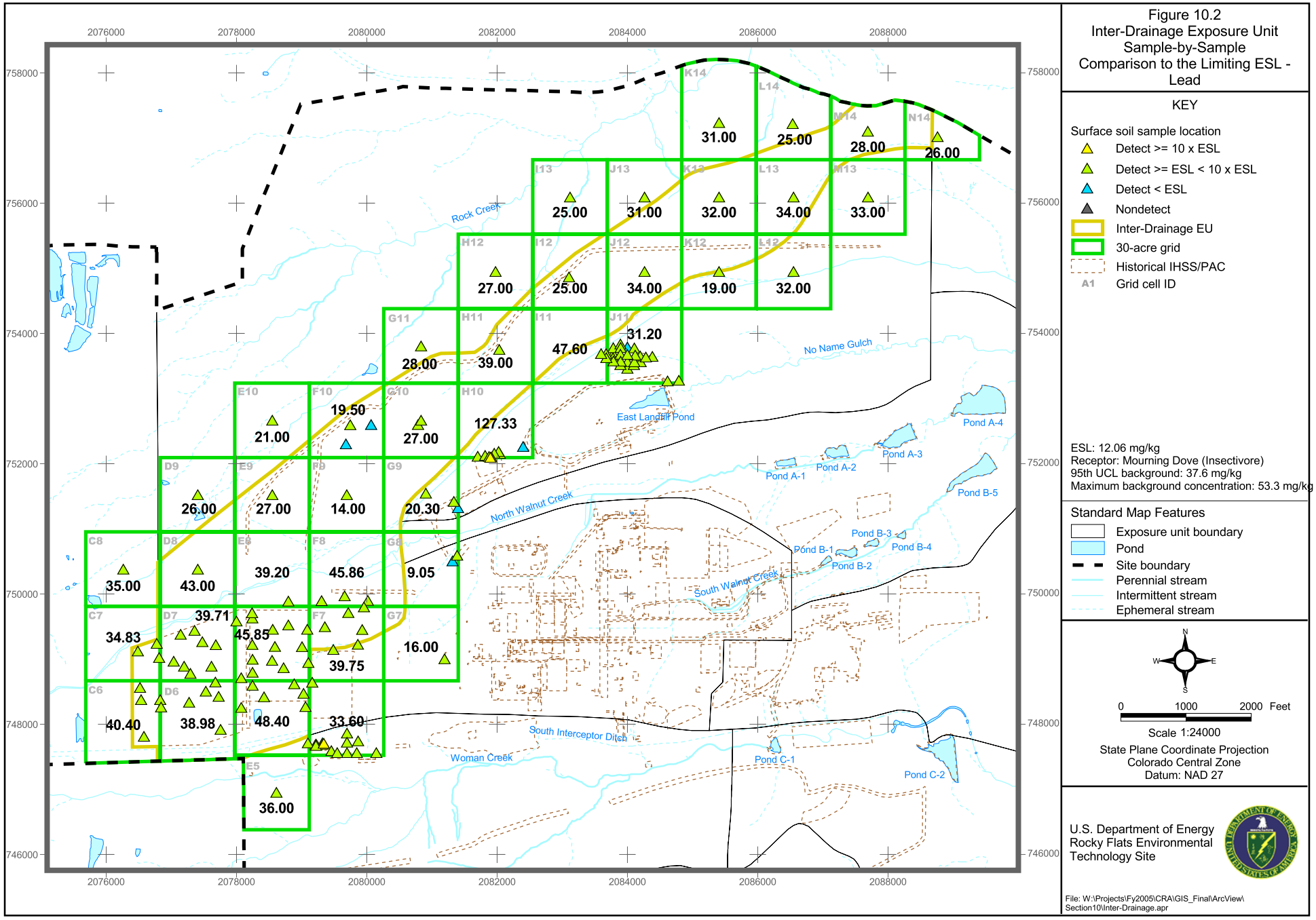

Figure 10.2
Inter-Drainage Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Lead

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Inter-Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 12.06 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 37.6 mg/kg
Maximum background concentration: 53.3 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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COMPREHENSIVE RISK ASSESSMENT

INTER-DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
CD	compact disc
CDH	Colorado Department of Health
CLP	Contract Laboratory Program
CRA	Comprehensive Risk Assessment
CRQL	Contract Required Quantitation Limit
DDT	dichlorodiphenyltrichloroethane
DOE	Department of Energy
ECOI	Ecological Contaminant of Interest
EPA	Environmental Protection Agency
ESL	ecological screening level
EU	Exposure Unit
IDEU	Inter-Drainage Exposure Unit
IDL	instrument detection limit
IHSS	Individual Hazardous Substance Site
LOAEL	Lowest Observed Adverse Effect Level
MDL	method detection limit
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
PCOC	Potential Contaminant of Concern
PRG	preliminary remediation goal
RL	reporting limit

SQL	sample quantitation limit
SVOC	Semi-volatile organic compound
SWD	soil water database
WRW	wildlife refuge worker

1.0 INTRODUCTION

For the Inter-Drainage Exposure Unit (EU) (IDEU), the detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and the minimum ecological screening levels (ESLs). The comparisons are made in the tables to this attachment for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The percent of the samples with detection limits that exceed the PRGs and ESLs are listed in these tables. When these detection limits exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, which is discussed herein.

Laboratory reported results for "U" qualified data (nondetects) are used to perform the detection limit screen rather than the detection limit identified in the detection limit field within the Soil Water Database (SWD). The basis for the detection limit is not always certain, i.e., Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), Sample Quantitation Limit (SQL), etc. Therefore, to be consistent in reporting, the "reported results" are presented in the tables to this attachment. Also, for statistical computations and risk estimations presented in the main text and tables to this volume, one-half the reported results are used as proxy values for nondetected data.

The term analyte as used in the following sections refers to analytes that are non-detected or detected in less than 5 percent of the samples. PRGs and ESLs do not exist for some of these analytes, which is also a source of uncertainty for the risk assessment. This uncertainty is discussed in Sections 6.2.1 and 10.3.2 of the main text of this volume.

2.0 COMPARISON OF REPORTED RESULTS TO PRELIMINARY REMEDIATION GOALS

2.1 Surface Soil/Surface Sediment

All reported results are below the PRGs in surface soil/surface sediment (Table A1.1).

2.2 Subsurface Soil/Subsurface Sediment

All reported results are below the PRGs in subsurface soil/subsurface sediment (Table A1.2).

3.0 COMPARISON OF REPORTED RESULTS TO ECOLOGICAL SCREENING LEVELS

3.1 Surface Soil

All reported results are below the ESLs in surface soil (Table A1.3).

3.2 Subsurface Soil

All reported results are below the ESLs in subsurface soil (Table A1.4).

TABLES

Table A1.1
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Cesium	8.30	-	15.8	50		0	0	No
Cyanide	2.50	-	4.70	50	2,222	0	0	No
Organic (ug/kg)		-						
1,1,1,2-Tetrachloroethane	1.28	-	1.33	3	91,018	0	0	No
1,1,1-Trichloroethane	1.14	-	1.18	3	9.18E+06	0	0	No
1,1,2,2-Tetrachloroethane	1.18	-	1.22	3	10,483	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	1.94	-	2.01	3	2.38E+09	0	0	No
1,1,2-Trichloroethane	0.963	-	1.00	3	28,022	0	0	No
1,1-Dichloroethane	1.02	-	1.06	3	2.72E+06	0	0	No
1,1-Dichloroethene	1.54	-	1.60	3	17,366	0	0	No
1,1-Dichloropropene	1.30	-	1.36	3		0	0	No
1,2,3-Trichlorobenzene	1.48	-	1.54	3		0	0	No
1,2,3-Trichloropropane	1.07	-	1.12	3	2,079	0	0	No
1,2,4-Trichlorobenzene	1.49	-	1.55	3	151,360	0	0	No
1,2,4-Trimethylbenzene	1.06	-	1.10	3	132,620	0	0	No
1,2-Dibromo-3-chloropropane	2.76	-	2.87	3	2,968	0	0	No
1,2-Dibromoethane	1.16	-	1.20	3	35.1	0	0	No
1,2-Dichlorobenzene	1.33	-	1.38	3	2.89E+06	0	0	No
1,2-Dichloroethane	1.17	-	1.21	3	13,270	0	0	No
1,2-Dichloropropane	0.942	-	0.980	3	38,427	0	0	No
1,3,5-Trimethylbenzene	0.731	-	0.760	3	114,340	0	0	No
1,3-Dichlorobenzene	1.46	-	1.52	3	3.33E+06	0	0	No
1,3-Dichloropropane	0.817	-	0.850	3		0	0	No
1,4-Dichlorobenzene	1.15	-	1.19	3	91,315	0	0	No
2,2-Dichloropropane	1.08	-	1.12	3		0	0	No
2-Butanone	10.3	-	10.8	3	4.64E+07	0	0	No
2-Chlorotoluene	1.64	-	1.70	3	2.22E+06	0	0	No
2-Hexanone	8.28	-	8.61	3		0	0	No
4-Chlorotoluene	0.959	-	0.997	3		0	0	No
4-Isopropyltoluene	1.21	-	1.26	3		0	0	No
4-Methyl-2-pentanone	7.00	-	7.28	3	8.32E+07	0	0	No
Acetone	24.0	-	25.0	3	1.00E+08	0	0	No
Benzene	0.888	-	0.923	3	23,563	0	0	No
Bromobenzene	1.35	-	1.40	3		0	0	No
Bromochloromethane	1.29	-	1.34	3		0	0	No
Bromodichloromethane	0.709	-	0.737	3	67,070	0	0	No
Bromoform	1.15	-	1.20	3	419,858	0	0	No
Bromomethane	1.65	-	1.72	3	20,959	0	0	No
Carbon Disulfide	2.86	-	2.97	3	1.64E+06	0	0	No
Carbon Tetrachloride	1.22	-	1.26	3	8,446	0	0	No
Chlorobenzene	1.02	-	1.06	3	666,523	0	0	No
Chloroethane	4.02	-	4.19	3	1.43E+06	0	0	No
Chloroform	0.926	-	0.963	3	7,850	0	0	No
Chloromethane	1.44	-	1.50	3	115,077	0	0	No
cis-1,2-Dichloroethene	1.29	-	1.35	3	1.11E+06	0	0	No
cis-1,3-Dichloropropene	0.902	-	0.938	3	19,432	0	0	No
Dibromochloromethane	1.03	-	1.08	3	49,504	0	0	No
Dibromomethane	1.14	-	1.18	3		0	0	No
Ethylbenzene	0.893	-	0.929	3	5.39E+06	0	0	No
Hexachlorobutadiene	1.57	-	1.63	3	22,217	0	0	No
Isopropylbenzene	1.34	-	1.39	3	32,680	0	0	No
Methylene Chloride	1.34	-	1.39	3	271,792	0	0	No
Naphthalene	1.39	-	1.45	3	1.40E+06	0	0	No
n-Butylbenzene	1.07	-	1.11	3		0	0	No
n-Propylbenzene	1.19	-	1.23	3		0	0	No
sec-Butylbenzene	1.12	-	1.17	3		0	0	No
Styrene	1.08	-	1.12	3	1.38E+07	0	0	No
tert-Butylbenzene	1.18	-	1.22	3		0	0	No
Tetrachloroethene	1.41	-	1.46	3	6,705	0	0	No
Toluene	1.36	-	1.41	3	3.09E+06	0	0	No
trans-1,2-Dichloroethene	1.44	-	1.50	3	287,340	0	0	No
trans-1,3-Dichloropropene	1.01	-	1.05	3	20,820	0	0	No
Trichloroethene	0.765	-	0.796	3	1,770	0	0	No
Trichlorofluoromethane	1.34	-	1.40	3	1.51E+06	0	0	No
Vinyl Chloride	3.03	-	3.15	3	2,169	0	0	No
Xylene	2.69	-	2.80	3	1.06E+06	0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.280	-	33.8	69	511	0	0	Yes
Boron	1	-	4.60	6	108,980	0	0	No
Cadmium	0.0620	-	3	69	1,051	0	0	No
Cyanide	2.50	-	2.80	55	25,550	0	0	No
Organic (ug/kg)		-						
1,1,1,2-Tetrachloroethane	1.18	-	1.35	6	1.05E+06	0	0	No
1,1,1-Trichloroethane	1.04	-	7	53	1.06E+08	0	0	No
1,1,2,2-Tetrachloroethane	1.08	-	7	54	120,551	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	1.78	-	2.03	6	2.74E+10	0	0	No
1,1,2-Trichloroethane	0.885	-	7	53	322,253	0	0	No
1,1-Dichloroethane	0.938	-	7	53	3.12E+07	0	0	No
1,1-Dichloroethene	1.41	-	7	53	199,706	0	0	No
1,1-Dichloropropene	1.20	-	1.37	6		0	0	No
1,2,3-Trichlorobenzene	1.36	-	1.55	6		0	0	No
1,2,3-Trichloropropane	0.987	-	1.13	6	23,910	0	0	No
1,2,4-Trichlorobenzene	1.37	-	370	61	1.74E+06	0	0	No
1,2,4-Trimethylbenzene	0.970	-	1.11	6	1.53E+06	0	0	No
1,2-Dibromo-3-chloropropane	2.54	-	2.90	6	34,137	0	0	No
1,2-Dibromoethane	1.06	-	1.21	6	403	0	0	No
1,2-Dichlorobenzene	1.22	-	370	61	3.32E+07	0	0	No
1,2-Dichloroethane	1.07	-	7	53	152,603	0	0	No
1,2-Dichloroethene	5	-	7	47	1.15E+07	0	0	No
1,2-Dichloropropane	0.865	-	7	53	441,907	0	0	No
1,3,5-Trimethylbenzene	0.671	-	0.768	6	1.31E+06	0	0	No
1,3-Dichlorobenzene	1.35	-	370	61	3.83E+07	0	0	No
1,3-Dichloropropane	0.751	-	0.859	6		0	0	No
1,4-Dichlorobenzene	1.06	-	370	61	1.05E+06	0	0	No
2,2-Dichloropropane	0.992	-	1.13	6		0	0	No
2,4,5-Trichlorophenol	1,700	-	1,900	55	9.22E+07	0	0	No
2,4,6-Trichlorophenol	330	-	370	55	3.13E+06	0	0	No
2,4-Dichlorophenol	330	-	370	55	2.76E+06	0	0	No
2,4-Dimethylphenol	330	-	370	55	1.84E+07	0	0	No
2,4-Dinitrophenol	1,700	-	1,900	45	1.84E+06	0	0	No
2,4-Dinitrotoluene	330	-	370	55	1.84E+06	0	0	No
2,6-Dinitrotoluene	330	-	370	55	921,651	0	0	No
2-Butanone	9.50	-	13	44	5.33E+08	0	0	Yes
2-Chloronaphthalene	330	-	370	55	7.37E+07	0	0	No
2-Chlorophenol	330	-	370	55	6.39E+06	0	0	No
2-Chlorotoluene	1.50	-	1.72	6	2.56E+07	0	0	No
2-Hexanone	7.61	-	13	46		0	0	No
2-Methylnaphthalene	330	-	370	55	3.69E+06	0	0	No
2-Methylphenol	330	-	370	52	4.61E+07	0	0	No
2-Nitroaniline	1,700	-	1,900	55	2.21E+06	0	0	No
2-Nitrophenol	330	-	370	55		0	0	No
3,3'-Dichlorobenzidine	660	-	740	52	76,667	0	0	No
3-Nitroaniline	1,700	-	1,900	46		0	0	No
4,6-Dinitro-2-methylphenol	1,700	-	1,900	54	92,165	0	0	No
4-Bromophenyl-phenylether	330	-	370	55		0	0	No
4-Chloro-3-methylphenol	330	-	370	55		0	0	No
4-Chloroaniline	330	-	370	52	3.69E+06	0	0	No
4-Chlorophenyl-phenyl ether	330	-	370	55		0	0	No
4-Chlorotoluene	0.881	-	1.01	6		0	0	No
4-Isopropyltoluene	1.11	-	1.27	6		0	0	No
4-Methyl-2-pentanone	6.43	-	13	46	9.57E+08	0	0	No
4-Methylphenol	330	-	370	55	4.61E+06	0	0	No
4-Nitroaniline	1,700	-	1,900	55	2.39E+06	0	0	No
4-Nitrophenol	1,700	-	1,900	55	7.37E+06	0	0	No
Acenaphthene	330	-	370	55	5.10E+07	0	0	No
Acenaphthylene	330	-	370	55		0	0	No
Anthracene	330	-	370	55	2.55E+08	0	0	No
Benzene	0.816	-	7	53	270,977	0	0	No
Benzo(a)anthracene	330	-	370	55	43,616	0	0	No
Benzo(a)pyrene	330	-	370	55	4,357	0	0	No
Benzo(b)fluoranthene	330	-	370	55	43,616	0	0	No
Benzo(g,h,i)perylene	330	-	370	55		0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Benzo(k)fluoranthene	330	-	370	55	436,159	0	0	No
Benzoic Acid	1,700	-	1,900	52	3.69E+09	0	0	No
Benzyl Alcohol	330	-	370	52	2.76E+08	0	0	No
bis(2-Chloroethoxy) methane	330	-	370	55		0	0	No
bis(2-Chloroethyl) ether	330	-	370	55	43,315	0	0	No
bis(2-Chloroisopropyl) ether	330	-	370	55	681,967	0	0	No
Bromobenzene	1.24	-	1.42	6		0	0	No
Bromochloromethane	1.19	-	1.36	6		0	0	No
Bromodichloromethane	0.651	-	7	53	771,304	0	0	No
Bromoform	1.06	-	7	54	4.83E+06	0	0	No
Bromomethane	1.52	-	13	53	241,033	0	0	No
Butylbenzylphthalate	330	-	370	55	1.84E+08	0	0	No
Carbon Disulfide	2.63	-	7	49	1.88E+07	0	0	No
Carbon Tetrachloride	1.12	-	7	53	97,124	0	0	No
Chlorobenzene	0.939	-	7	54	7.67E+06	0	0	No
Chloroethane	3.70	-	13	53	1.65E+07	0	0	No
Chloroform	0.850	-	7	53	90,270	0	0	Yes
Chloromethane	1.33	-	13	53	1.32E+06	0	0	No
Chrysene	330	-	370	55	4.36E+06	0	0	No
cis-1,2-Dichloroethene	1.19	-	1.36	6	1.28E+07	0	0	No
cis-1,3-Dichloropropene	0.829	-	7	53	223,462	0	0	No
Dibenz(a,h)anthracene	330	-	370	55	4,362	0	0	No
Dibenzofuran	330	-	370	55	2.56E+06	0	0	No
Dibromochloromethane	0.950	-	7	53	569,296	0	0	No
Dibromomethane	1.05	-	1.20	6		0	0	No
Diethylphthalate	330	-	370	53	7.37E+08	0	0	Yes
Dimethylphthalate	330	-	370	55	9.22E+09	0	0	No
Di-n-octylphthalate	330	-	370	55	3.69E+07	0	0	No
Ethylbenzene	0.821	-	7	54	6.19E+07	0	0	No
Fluoranthene	330	-	370	55	3.40E+07	0	0	No
Fluorene	330	-	370	55	3.69E+07	0	0	No
Hexachlorobenzene	330	-	370	55	21,508	0	0	No
Hexachlorobutadiene	1.44	-	370	61	255,500	0	0	No
Hexachlorocyclopentadiene	330	-	370	45	4.38E+06	0	0	No
Hexachloroethane	330	-	370	55	1.28E+06	0	0	No
Indeno(1,2,3-cd)pyrene	330	-	370	55	43,616	0	0	No
Isophorone	330	-	370	55	3.63E+07	0	0	No
Isopropylbenzene	1.23	-	1.40	6	375,823	0	0	No
Naphthalene	1.28	-	370	61	1.61E+07	0	0	No
n-Butylbenzene	0.980	-	1.12	6		0	0	No
Nitrobenzene	330	-	370	55	497,333	0	0	No
N-Nitroso-di-n-propylamine	330	-	370	55	4,929	0	0	No
N-nitrosodiphenylamine	330	-	370	55	7.04E+06	0	0	No
n-Propylbenzene	1.09	-	1.25	6		0	0	No
Pentachlorophenol	1,700	-	1,900	55	202,777	0	0	No
Phenanthrene	330	-	370	55		0	0	No
Phenol	330	-	370	55	2.76E+08	0	0	No
Pyrene	330	-	370	55	2.55E+07	0	0	No
sec-Butylbenzene	1.03	-	1.18	6		0	0	No
Styrene	0.992	-	7	54	1.59E+08	0	0	No
tert-Butylbenzene	1.08	-	1.24	6		0	0	No
Tetrachloroethene	1.29	-	7	54	77,111	0	0	No
trans-1,2-Dichloroethene	1.32	-	1.51	6	3.30E+06	0	0	No
trans-1,3-Dichloropropene	0.929	-	7	54	239,434	0	0	No
Trichloroethene	0.703	-	7	53	20,354	0	0	No
Trichlorofluoromethane	1.24	-	1.41	6	1.74E+07	0	0	No
Vinyl acetate	10	-	13	47	3.04E+07	0	0	No
Vinyl Chloride	2.79	-	13	53	24,948	0	0	No
Xylene	2.48	-	7	53	1.22E+07	0	0	Yes

Table A1.3
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Cesium	8.30	-	15.8	50		0	0	No
Cyanide	2.50	-	4.70	50	607	0	0	No
Organic (ug/kg)		-						
1,1,1,2-Tetrachloroethane	1.28	-	1.33	3		0	0	No
1,1,1-Trichloroethane	1.14	-	1.18	3	551,453	0	0	No
1,1,2,2-Tetrachloroethane	1.18	-	1.22	3	60,701	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	1.94	-	2.01	3		0	0	No
1,1,2-Trichloroethane	0.963	-	1.00	3		0	0	No
1,1-Dichloroethane	1.02	-	1.06	3	3,121	0	0	No
1,1-Dichloroethene	1.54	-	1.60	3	16,909	0	0	No
1,1-Dichloropropene	1.30	-	1.36	3		0	0	No
1,2,3-Trichlorobenzene	1.48	-	1.54	3		0	0	No
1,2,3-Trichloropropane	1.07	-	1.12	3	13,883	0	0	No
1,2,4-Trichlorobenzene	1.49	-	1.55	3	777	0	0	No
1,2,4-Trimethylbenzene	1.06	-	1.10	3		0	0	No
1,2-Dibromo-3-chloropropane	2.76	-	2.87	3		0	0	No
1,2-Dibromoethane	1.16	-	1.20	3		0	0	No
1,2-Dichlorobenzene	1.33	-	1.38	3		0	0	No
1,2-Dichloroethane	1.17	-	1.21	3	2,764	0	0	No
1,2-Dichloropropane	0.942	-	0.980	3	49,910	0	0	No
1,3,5-Trimethylbenzene	0.731	-	0.760	3	7,598	0	0	No
1,3-Dichlorobenzene	1.46	-	1.52	3		0	0	No
1,3-Dichloropropane	0.817	-	0.850	3		0	0	No
1,4-Dichlorobenzene	1.15	-	1.19	3	20,000	0	0	No
2,2-Dichloropropane	1.08	-	1.12	3		0	0	No
2-Butanone	10.3	-	10.8	3	1.07E+06	0	0	No
2-Chlorotoluene	1.64	-	1.70	3		0	0	No
2-Hexanone	8.28	-	8.61	3		0	0	No
4-Chlorotoluene	0.959	-	0.997	3		0	0	No
4-Isopropyltoluene	1.21	-	1.26	3		0	0	No
4-Methyl-2-pentanone	7.00	-	7.28	3	14,630	0	0	No
Acetone	24.0	-	25.0	3	6,182	0	0	No
Benzene	0.888	-	0.923	3	500	0	0	No
Bromobenzene	1.35	-	1.40	3		0	0	No
Bromochloromethane	1.29	-	1.34	3		0	0	No
Bromodichloromethane	0.709	-	0.737	3	5,750	0	0	No
Bromoform	1.15	-	1.20	3	2,855	0	0	No
Bromomethane	1.65	-	1.72	3		0	0	No
Carbon Disulfide	2.86	-	2.97	3	5,676	0	0	No
Carbon Tetrachloride	1.22	-	1.26	3	8,906	0	0	No
Chlorobenzene	1.02	-	1.06	3	4,750	0	0	No
Chloroethane	4.02	-	4.19	3		0	0	No
Chloroform	0.926	-	0.963	3	8,655	0	0	No
Chloromethane	1.44	-	1.50	3		0	0	No
cis-1,2-Dichloroethene	1.29	-	1.35	3	1,814	0	0	No
cis-1,3-Dichloropropene	0.902	-	0.938	3	2,800	0	0	No
Dibromochloromethane	1.03	-	1.08	3	5,730	0	0	No
Dibromomethane	1.14	-	1.18	3		0	0	No
Ethylbenzene	0.893	-	0.929	3		0	0	No
Hexachlorobutadiene	1.57	-	1.63	3	431	0	0	No
Isopropylbenzene	1.34	-	1.39	3		0	0	No
Methylene Chloride	1.34	-	1.39	3	3,399	0	0	No
Naphthalene	1.39	-	1.45	3	27,048	0	0	No
n-Butylbenzene	1.07	-	1.11	3		0	0	No
n-Propylbenzene	1.19	-	1.23	3		0	0	No
sec-Butylbenzene	1.12	-	1.17	3		0	0	No
Styrene	1.08	-	1.12	3	16,408	0	0	No
tert-Butylbenzene	1.18	-	1.22	3		0	0	No
Tetrachloroethene	1.41	-	1.46	3	763	0	0	No
Toluene	1.36	-	1.41	3	14,416	0	0	No
trans-1,2-Dichloroethene	1.44	-	1.50	3	25,617	0	0	No
trans-1,3-Dichloropropene	1.01	-	1.05	3	2,800	0	0	No
Trichloroethene	0.765	-	0.796	3	389	0	0	No
Trichlorofluoromethane	1.34	-	1.40	3		0	0	No
Vinyl Chloride	3.03	-	3.15	3	97.7	0	0	No
Xylene	2.69	-	2.80	3	1,140	0	0	No

Table A1.4
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.280	-	33.8	69	18.7	1	1.45	Yes
Boron	1	-	4.60	6	237	0	0	No
Cadmium	0.0620	-	3	69	198	0	0	No
Cyanide	2.50	-	2.80	55	2,200	0	0	No
Organic (ug/kg)		-						
1,1,1,2-Tetrachloroethane	1.18	-	1.35	6		0	0	No
1,1,1-Trichloroethane	1.04	-	7	53	4.85E+07	0	0	No
1,1,2,2-Tetrachloroethane	1.08	-	7	54	4.70E+06	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	1.78	-	2.03	6		0	0	No
1,1,2-Trichloroethane	0.885	-	7	53		0	0	No
1,1-Dichloroethane	0.938	-	7	53	215,360	0	0	No
1,1-Dichloroethene	1.41	-	7	53	1.28E+06	0	0	No
1,1-Dichloropropene	1.20	-	1.37	6		0	0	No
1,2,3-Trichlorobenzene	1.36	-	1.55	6		0	0	No
1,2,3-Trichloropropane	0.987	-	1.13	6	1.17E+06	0	0	No
1,2,4-Trichlorobenzene	1.37	-	370	61	94,484	0	0	No
1,2,4-Trimethylbenzene	0.970	-	1.11	6		0	0	No
1,2-Dibromo-3-chloropropane	2.54	-	2.90	6		0	0	No
1,2-Dibromoethane	1.06	-	1.21	6		0	0	No
1,2-Dichlorobenzene	1.22	-	370	61		0	0	No
1,2-Dichloroethane	1.07	-	7	53	2.00E+06	0	0	No
1,2-Dichloroethene	5	-	7	47	1.87E+06	0	0	No
1,2-Dichloropropane	0.865	-	7	53	3.92E+06	0	0	No
1,3,5-Trimethylbenzene	0.671	-	0.768	6	855,709	0	0	No
1,3-Dichlorobenzene	1.35	-	370	61		0	0	No
1,3-Dichloropropane	0.751	-	0.859	6		0	0	No
1,4-Dichlorobenzene	1.06	-	370	61	5.93E+06	0	0	No
2,2-Dichloropropane	0.992	-	1.13	6		0	0	No
2,4,5-Trichlorophenol	1,700	-	1,900	55		0	0	No
2,4,6-Trichlorophenol	330	-	370	55	17,263	0	0	No
2,4-Dichlorophenol	330	-	370	55	249,324	0	0	No
2,4-Dimethylphenol	330	-	370	55		0	0	No
2,4-Dinitrophenol	1,700	-	1,900	45	4.90E+06	0	0	No
2,4-Dinitrotoluene	330	-	370	55	2,473	0	0	No
2,6-Dinitrotoluene	330	-	370	55	477,309	0	0	No
2-Butanone	9.50	-	13	44	4.94E+07	0	0	Yes
2-Chloronaphthalene	330	-	370	55		0	0	No
2-Chlorophenol	330	-	370	55	21,598	0	0	No
2-Chlorotoluene	1.50	-	1.72	6		0	0	No
2-Hexanone	7.61	-	13	46		0	0	No
2-Methylnaphthalene	330	-	370	55	319,121	0	0	No
2-Methylphenol	330	-	370	52	9.26E+06	0	0	No
2-Nitroaniline	1,700	-	1,900	55	418,475	0	0	No
2-Nitrophenol	330	-	370	55		0	0	No
3,3'-Dichlorobenzidine	660	-	740	52		0	0	No
3-Nitroaniline	1,700	-	1,900	46		0	0	No
4,6-Dinitro-2-methylphenol	1,700	-	1,900	54	44,283	0	0	No
4-Bromophenyl-phenylether	330	-	370	55		0	0	No
4-Chloro-3-methylphenol	330	-	370	55		0	0	No
4-Chloroaniline	330	-	370	52	48,856	0	0	No
4-Chlorophenyl-phenyl ether	330	-	370	55		0	0	No
4-Chlorotoluene	0.881	-	1.01	6		0	0	No
4-Isopropyltoluene	1.11	-	1.27	6		0	0	No
4-Methyl-2-pentanone	6.43	-	13	46	859,131	0	0	No
4-Methylphenol	330	-	370	55		0	0	No
4-Nitroaniline	1,700	-	1,900	55	2.62E+06	0	0	No
4-Nitrophenol	1,700	-	1,900	55	1.02E+06	0	0	No
Acenaphthene	330	-	370	55		0	0	No
Acenaphthylene	330	-	370	55		0	0	No
Anthracene	330	-	370	55		0	0	No
Benzene	0.816	-	7	53	1.10E+06	0	0	No
Benzo(a)anthracene	330	-	370	55		0	0	No
Benzo(a)pyrene	330	-	370	55	502,521	0	0	No
Benzo(b)fluoranthene	330	-	370	55		0	0	No
Benzo(g,h,i)perylene	330	-	370	55		0	0	No

Table A1.4
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil in the IDEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Benzo(k)fluoranthene	330	-	370	55		0	0	No
Benzoic Acid	1,700	-	1,900	52		0	0	No
Benzyl Alcohol	330	-	370	52	253,015	0	0	No
bis(2-Chloroethoxy) methane	330	-	370	55		0	0	No
bis(2-Chloroethyl) ether	330	-	370	55		0	0	No
bis(2-Chloroisopropyl) ether	330	-	370	55		0	0	No
Bromobenzene	1.24	-	1.42	6		0	0	No
Bromochloromethane	1.19	-	1.36	6		0	0	No
Bromodichloromethane	0.651	-	7	53	381,135	0	0	No
Bromoform	1.06	-	7	54	198,571	0	0	No
Bromomethane	1.52	-	13	53		0	0	No
Butylbenzylphthalate	330	-	370	55	3.37E+06	0	0	No
Carbon Disulfide	2.63	-	7	49	410,941	0	0	No
Carbon Tetrachloride	1.12	-	7	53	736,154	0	0	No
Chlorobenzene	0.939	-	7	54	413,812	0	0	No
Chloroethane	3.70	-	13	53		0	0	No
Chloroform	0.850	-	7	53	560,030	0	0	Yes
Chloromethane	1.33	-	13	53		0	0	No
Chrysene	330	-	370	55		0	0	No
cis-1,2-Dichloroethene	1.19	-	1.36	6	132,702	0	0	No
cis-1,3-Dichloropropene	0.829	-	7	53	222,413	0	0	No
Dibenz(a,h)anthracene	330	-	370	55		0	0	No
Dibenzofuran	330	-	370	55	2.44E+06	0	0	No
Dibromochloromethane	0.950	-	7	53	389,064	0	0	No
Dibromomethane	1.05	-	1.20	6		0	0	No
Diethylphthalate	330	-	370	53	2.21E+08	0	0	Yes
Dimethylphthalate	330	-	370	55	1.35E+07	0	0	No
Di-n-octylphthalate	330	-	370	55	2.58E+08	0	0	No
Ethylbenzene	0.821	-	7	54		0	0	No
Fluoranthene	330	-	370	55		0	0	No
Fluorene	330	-	370	55		0	0	No
Hexachlorobenzene	330	-	370	55	190,142	0	0	No
Hexachlorobutadiene	1.44	-	370	61	150,894	0	0	No
Hexachlorocyclopentadiene	330	-	370	45	799,679	0	0	No
Hexachloroethane	330	-	370	55	45,656	0	0	No
Indeno(1,2,3-cd)pyrene	330	-	370	55		0	0	No
Isophorone	330	-	370	55		0	0	No
Isopropylbenzene	1.23	-	1.40	6		0	0	No
Naphthalene	1.28	-	370	61	1.60E+07	0	0	No
n-Butylbenzene	0.980	-	1.12	6		0	0	No
Nitrobenzene	330	-	370	55		0	0	No
N-Nitroso-di-n-propylamine	330	-	370	55		0	0	No
N-nitrosodiphenylamine	330	-	370	55	2.15E+06	0	0	No
n-Propylbenzene	1.09	-	1.25	6		0	0	No
Pentachlorophenol	1,700	-	1,900	55	18,373	0	0	No
Phenanthrene	330	-	370	55		0	0	No
Phenol	330	-	370	55	1.49E+06	0	0	No
Pyrene	330	-	370	55		0	0	No
sec-Butylbenzene	1.03	-	1.18	6		0	0	No
Styrene	0.992	-	7	54	1.53E+06	0	0	No
tert-Butylbenzene	1.08	-	1.24	6		0	0	No
Tetrachloroethene	1.29	-	7	54	72,494	0	0	No
trans-1,2-Dichloroethene	1.32	-	1.51	6	1.87E+06	0	0	No
trans-1,3-Dichloropropene	0.929	-	7	54	222,413	0	0	No
Trichloroethene	0.703	-	7	53	32,424	0	0	No
Trichlorofluoromethane	1.24	-	1.41	6		0	0	No
Vinyl acetate	10	-	13	47	730,903	0	0	No
Vinyl Chloride	2.79	-	13	53	6,494	0	0	No
Xylene	2.48	-	7	53	111,663	0	0	Yes

COMPREHENSIVE RISK ASSESSMENT
INTER DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 2
Data Quality Assessment

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DAR	data adequacy report
DER	duplicate error ratio
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
ECOPC	ecological contaminant of potential concern
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESL	ecological screening level
EU	exposure unit
FD	field duplicate
IAG	Interagency Agreement
ICP	inductively couple plasma
IDEU	Inter Drainage Exposure Unit
IDL	instrument detection limit
LCS	laboratory control sample

MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate
N/A	not applicable
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	Pipette
PRG	preliminary remediation goal
PCB	polychlorinated biphenyl
QC	quality control
RDL	required detection limit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

1.0 INTRODUCTION

This document provides an assessment of the quality of the data used in the human health and ecological risk assessments for the Inter Drainage Exposure Unit (IDEU). The data quality was evaluated against standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters by the data validator under the multiple work plans that guided the data collection over the past 15 years, as well as the requirements for the PARCC parameters provided in the Comprehensive Risk Assessment (CRA) Methodology (DOE 2005). The details of this data quality assessment (DQA) process are presented in the Sitewide DQA contained in Appendix A, Volume 2, Attachment 2 of the Remedial Investigation/Feasibility Study (RI/FS).

Of the 108,806 environmental sampling records in the RFETS database associated with the IDEU, 56,126 were used in the IDEU risk assessment based on the data processing rules described in Section 2.0 of the Sitewide DQA. Of the 56,126 analytical records existing in the IDEU CRA data set, 92 percent (51,456 records) have undergone verification or validation (V&V) (Table A2.1). The V&V review involved applying observation notes and qualifiers flags or observation notes without qualifier flags to the data.

PARCC parameter analysis was used to determine if the data quality could affect the risk assessment decisions (i.e., have significant impact on risk calculations or selection of contaminants of concern [COCs] for human health or ecological contaminants of potential concern [ECOPCs]). In consultation with the data users and project team, the primary ways in which the PARCC parameters could impact the risk assessment decisions were identified and these include the following:

- Detect results are falsely identified as nondetects;
- Nondetect results are falsely identified as detects;
- Issues that cause detection limit uncertainty;
- Issues that cause significant overestimation of detect results; and
- Issues that cause significant underestimation of detect results.

2.0 SUMMARY OF FINDINGS

2.1 PARCC Findings

A summary of V&V observations and the associated, affected PARCC parameter is presented in Table A2.2 by analyte group and matrix (i.e., “soil” includes soil and sediment, and “water” includes surface water and groundwater). Table A2.3 presents the percentage of the IDEU V&V data that were qualified as estimated and/or undetected by

analyte group and matrix. Overall, approximately 10 percent of the IDEU CRA data were qualified as estimated or undetected. Less than one percent of the data reported as detected by the laboratory were qualified as undetected by the validator due to blank contamination (Table A2.4). In general, data qualified as estimated or undetected are marked as such because of various laboratory noncompliance issues that are not serious enough to render the data unusable. The precision between field duplicate (FD)/target sample analyte pairs is summarized in Table A2.5.

Of the 92 percent of the IDEU data set that underwent V&V, 86 percent were qualified as having no QC issues, and approximately 10 percent were qualified as estimated or undetected (Table A2.3). The remaining 4 percent of the V&V data are made up of records qualified with additional flags indicating acceptable and non-estimated data such as “A”, “C”, or “E”.

Approximately 3 percent of the entire data set was rejected during the V&V process (Table A2.6). Rejected data were removed from the IDEU CRA data set during the data processing as defined in Section 2.0 of the Sitewide DQA.

The general discussion below summarizes the data quality as presented by the data validator’s observations. The relationship between these observations and the PARCC parameters can be found in the Sitewide DQA. Several observations have no impact on data quality because they represent issues that were noted but corrected, or represent other, general observations such as missing documentation that was not required for data assessment. Approximately 9 percent of the IDEU V&V data were marked with these V&V observations that have no affect on any of the PARCC parameters.

Of the V&V data, approximately 2 percent were noted for observations related to precision. Of that 2 percent, 98 percent contained issues related to sample matrices. Result confirmation and instrument setup observations make up the other 2 percent.

Of the V&V data, 23 percent were noted for accuracy-related observations. Of that 23 percent, 75 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 25 percent. It is important to note that not all accuracy-related observations resulted in data qualification. Only 10 percent of the IDEU CRA data set was qualified as estimated and/or undetected (Table A2.3).

The data were determined to meet the representativeness parameter because sampling locations are spatially distributed such that contaminant randomness and bias considerations are addressed based on the site-specific history (see the Data Adequacy Report [DAR] in Appendix A, Volume 2, Attachment 3). Samples were also analyzed by the SW-846 or alpha-spectroscopy methods and results were documented as quality records according to approved procedures and guidelines (V&V).

Of the V&V data, approximately 35 percent were noted for observations related to representativeness. Of that 35 percent, 90 percent was marked for blank observations, 4 percent for failure to observe allowed holding times, 3 percent for documentation issues, and 2 percent for instrument sensitivity issues. Matrix, LCS, instrument set-up, and other observations make up the other 1 percent of the data noted for observations related to

sample representativeness. Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs and samples were generally stored and preserved properly.

The CRA Methodology specifies completeness criteria based on data adequacy and these criteria and the findings are discussed in the DAR in Appendix A, Volume 2, Attachment 3 of the RI/FS. Additionally, it should be noted that only approximately 3 percent of all V&V data associated with the IDEU were rejected.

Comparability of the IDEU CRA data set is ensured as all analytical results have been converted into common units. Comparability is addressed more specifically in Appendix A, Volume 2, Attachment 2 of the RI/FS.

2.2 PARCC Findings Potential Impact on Data Usability

PARCC parameter influence on data usability is discussed below with an emphasis on the risk assessment decisions as described in the Introduction to this document.

Table A2.3 summarizes the overall percentage of qualified data, independent of validation observation. The table is used for overall guidance in selecting analyte group and matrix combinations of interest in the analysis of the risk assessment decisions, the impact on data usability is better analyzed using Tables A2.5 through A2.7, as these can be more directly related to the 5 key risk assessment decision factors described in the introduction.

A summary of FD/target sample precision information can be found in Table A2.5. Where there are analyte group and matrix combinations failures that have the potential to impact risk assessment decisions, the data quality is discussed in further detail in the bulleted list below.

Table A2.7 lists V&V observations where the number of observations by analyte group and matrix exceeds 5 percent of the associated records (see column “Percent Observed”) with the exception of those observations that were determined to have no impact on any of the PARCC parameters. Such observations are identified in Table A2.2 by an “Affected PARCC Parameter” of not applicable (N/A). Additionally the analyte group and matrix is broken down further in the columns “Percent Qualified U” and “Percent Qualified J”. Data qualifications that are considered to have potential impact on risk assessment decisions were reviewed and are discussed in detail in the bulleted list below. Other issues are not considered to have the potential for significant impacts on the results of the risk assessments because the uncertainty associated with these data quality issues is assumed to be less than the overall uncertainty in the risk assessment process (e.g., uncertainties such as exposure assumptions, toxicity values, and statistical methods for calculating exposure point concentrations).

Data qualifications associated with the water matrix are not discussed below. Surface water data are used in the ecological risk assessment for an EU only for those analytes

identified as ECOPCs, and the surface water component of exposure contributes only minimally to the overall risk estimates. As described in the Sitewide DQA (Attachment 2 of Volume 2 of Appendix A of the RI/FS Report), groundwater data are not used in the ecological risk assessment and the groundwater evaluations for the human health portion of the risk assessment are performed on a sitewide basis. In addition, surface water is evaluated for the human health risk assessment on a sitewide basis. Therefore, data quality evaluations for groundwater and surface water are presented in the Sitewide DQA.

An issue that has the potential to impact the risk assessment decisions is described below.

- Several V&V observations related to the wet chemistry/soil analyte group and matrix combination resulted in data qualifications in notable percentages of the data set (Table A2.7). Additionally, greater than 20 percent of all associated FD/target sample analyte pairs failed relative percent difference (RPD) criteria (Table A2.5). It is important to note, however, that this analyte group contains general chemistry parameters such as ions/anions and alkalinity that are not directly related to site characterization. Therefore, the impact of these qualifications on risk assessment results is determined to be minimal.

3.0 CONCLUSIONS

This review concludes that the quality of the IDEU data is acceptable and the CRA objectives for PARCC performance have generally been met. Where either CRA Methodology or V&V guidance have not been met, the data are either flagged by the V&V process, or for those instances where the frequency of issues may influence the risk assessment decisions, the data quality issues were reviewed for potential impact on risk assessment results.

Those elements of data quality that could affect risk assessment decisions in the IDEU have been analyzed and it was concluded that the noted deviations from the PARCC parameter criteria have minimal impact on risk assessment results related to the IDEU.

4.0 REFERENCES

DOE, 2002, Final Work Plan for the Development of the Remedial Investigation and Feasibility Study Report, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1, September 2005.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of CRA V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	Water	14	14	100.00
Herbicide	Soil	55	55	100.00
Herbicide	Water	142	153	92.81
Metal	Soil	3,834	3,834	100.00
Metal	Water	14,368	15,968	89.98
PCB	Water	175	203	86.21
Pesticide	Soil	45	45	100.00
Pesticide	Water	836	921	90.77
Radionuclide	Soil	689	723	95.30
Radionuclide	Water	3,830	4,537	84.42
SVOC	Soil	3,237	3,237	100.00
SVOC	Water	1,758	1,905	92.28
VOC	Soil	2,314	2,328	99.40
VOC	Water	17,512	19,291	90.78
Wet Chem	Soil	230	230	100.00
Wet Chem	Water	2,417	2,682	90.12
	Total	**51,456**	**56,126**	**91.68%**

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Herbicide	Water	Calibration	Continuing calibration verification criteria were not met	No	3	142	2.11	Accuracy
Herbicide	Water	Documentation Issues	Transcription error	No	21	142	14.79	N/A
Herbicide	Water	Documentation Issues	Transcription error	Yes	20	142	14.08	N/A
Herbicide	Water	Internal Standards	Internal standards did not meet criteria	No	2	142	1.41	Accuracy
Metal	Soil	Blanks	Calibration verification blank contamination	No	39	3,834	1.02	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	No	164	3,834	4.28	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	9	3,834	0.23	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	No	49	3,834	1.28	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	Yes	12	3,834	0.31	Representativeness
Metal	Soil	Calibration	Calibration correlation coefficient did not meet requirements	No	10	3,834	0.26	Accuracy
Metal	Soil	Calibration	Calibration correlation coefficient did not meet requirements	Yes	14	3,834	0.37	Accuracy
Metal	Soil	Documentation Issues	Transcription error	Yes	6	3,834	0.16	N/A
Metal	Soil	Instrument Set-up	Interference was indicated in the interference check sample	No	4	3,834	0.10	Accuracy
Metal	Soil	Instrument Set-up	Interference was indicated in the interference check sample	Yes	12	3,834	0.31	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	No	10	3,834	0.26	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	Yes	10	3,834	0.26	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	No	124	3,834	3.23	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	Yes	181	3,834	4.72	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	No	43	3,834	1.12	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	Yes	27	3,834	0.70	Accuracy
Metal	Soil	Matrices	Duplicate sample precision criteria were not met	No	10	3,834	0.26	Precision

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Soil	Matrices	Duplicate sample precision criteria were not met	Yes	56	3,834	1.46	Precision
Metal	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	9	3,834	0.23	Precision
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	No	8	3,834	0.21	Accuracy
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	Yes	14	3,834	0.37	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	No	104	3,834	2.71	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	183	3,834	4.77	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	9	3,834	0.23	Accuracy
Metal	Soil	Matrices	Serial dilution criteria were not met	Yes	74	3,834	1.93	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	162	3,834	4.23	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	438	3,834	11.42	Accuracy
Metal	Water	Blanks	Calibration verification blank contamination	No	57	14,368	0.40	Representativeness
Metal	Water	Blanks	Calibration verification blank contamination	Yes	6	14,368	0.04	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	1,354	14,368	9.42	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	188	14,368	1.31	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	No	198	14,368	1.38	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	Yes	99	14,368	0.69	Representativeness
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	No	81	14,368	0.56	Accuracy
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	14	14,368	0.10	Accuracy
Metal	Water	Calibration	Continuing calibration verification criteria were not met	No	8	14,368	0.06	Accuracy
Metal	Water	Documentation Issues	Key data fields incorrect	No	5	14,368	0.03	N/A

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Documentation Issues	Key data fields incorrect	Yes	20	14,368	0.14	N/A
Metal	Water	Documentation Issues	Record added by the validator	No	34	14,368	0.24	N/A
Metal	Water	Documentation Issues	Record added by the validator	Yes	22	14,368	0.15	N/A
Metal	Water	Documentation Issues	Transcription error	No	816	14,368	5.68	N/A
Metal	Water	Documentation Issues	Transcription error	Yes	187	14,368	1.30	N/A
Metal	Water	Holding Times	Holding times were exceeded	No	1	14,368	0.01	Representativeness
Metal	Water	Instrument Set-up	AA duplicate injection precision criteria were not met	Yes	1	14,368	0.01	Precision
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	No	7	14,368	0.05	Accuracy
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	Yes	13	14,368	0.09	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	No	63	14,368	0.44	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	Yes	70	14,368	0.49	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	No	4	14,368	0.03	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	Yes	13	14,368	0.09	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	No	2	14,368	0.01	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	Yes	5	14,368	0.03	Accuracy
Metal	Water	Matrices	Duplicate sample precision criteria were not met	No	24	14,368	0.17	Precision
Metal	Water	Matrices	Duplicate sample precision criteria were not met	Yes	133	14,368	0.93	Precision
Metal	Water	Matrices	MSA calibration correlation coefficient < 0.995	Yes	1	14,368	0.01	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	No	112	14,368	0.78	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	Yes	17	14,368	0.12	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	No	201	14,368	1.40	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	154	14,368	1.07	Accuracy
Metal	Water	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	14,368	0.01	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	No	2	14,368	0.01	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	Yes	141	14,368	0.98	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	No	51	14,368	0.35	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	Yes	61	14,368	0.42	Accuracy
Metal	Water	Other	See hard copy for further explanation	No	1	14,368	0.01	N/A
Metal	Water	Sensitivity	IDL changed due to a significant figure discrepancy	No	72	14,368	0.50	Representativeness
PCB	Water	Documentation Issues	Sample analysis was not requested	No	7	175	4.00	N/A
PCB	Water	Documentation Issues	Transcription error	No	61	175	34.86	N/A
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	56	175	32.00	Accuracy
Pesticide	Water	Blanks	Method, preparation, or reagent blank contamination	No	4	836	0.48	Representativeness
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	No	17	836	2.03	Accuracy
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	1	836	0.12	Accuracy
Pesticide	Water	Documentation Issues	Transcription error	No	92	836	11.00	N/A
Pesticide	Water	Internal Standards	Internal standards did not meet criteria	No	2	836	0.24	Accuracy
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	208	836	24.88	Accuracy
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	Yes	2	836	0.24	Accuracy
Radionuclide	Soil	Blanks	Blank recovery criteria were not met	Yes	7	689	1.02	Representativeness
Radionuclide	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	14	689	2.03	Representativeness
Radionuclide	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	8	689	1.16	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Soil	Documentation Issues	Record added by the validator	Yes	8	689	1.16	N/A
Radionuclide	Soil	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	31	689	4.50	Representativeness
Radionuclide	Soil	Documentation Issues	Transcription error	No	20	689	2.90	N/A
Radionuclide	Soil	Documentation Issues	Transcription error	Yes	33	689	4.79	N/A
Radionuclide	Soil	Instrument Set-up	Resolution criteria were not met	No	6	689	0.87	Representativeness
Radionuclide	Soil	Instrument Set-up	Resolution criteria were not met	Yes	14	689	2.03	Representativeness
Radionuclide	Soil	LCS	LCS recovery > +/- 3 sigma	Yes	6	689	0.87	Accuracy
Radionuclide	Soil	LCS	LCS recovery criteria were not met	Yes	5	689	0.73	Accuracy
Radionuclide	Soil	LCS	LCS relative percent error criteria not met	Yes	1	689	0.15	Accuracy
Radionuclide	Soil	Matrices	Recovery criteria were not met	No	1	689	0.15	Accuracy
Radionuclide	Soil	Matrices	Recovery criteria were not met	Yes	1	689	0.15	Accuracy
Radionuclide	Soil	Matrices	Replicate precision criteria were not met	Yes	4	689	0.58	Precision
Radionuclide	Soil	Other	QC sample does not meet method requirements	No	14	689	2.03	Representativeness
Radionuclide	Soil	Other	QC sample does not meet method requirements	Yes	11	689	1.60	Representativeness
Radionuclide	Soil	Other	Sample exceeded efficiency curve weight limit	Yes	4	689	0.58	Accuracy
Radionuclide	Soil	Sensitivity	MDA exceeded the RDL	No	2	689	0.29	Representativeness
Radionuclide	Soil	Sensitivity	MDA was calculated by reviewer	Yes	54	689	7.84	N/A
Radionuclide	Water	Blanks	Blank recovery criteria were not met	No	13	3,830	0.34	Representativeness
Radionuclide	Water	Blanks	Blank recovery criteria were not met	Yes	31	3,830	0.81	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	No	66	3,830	1.72	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	282	3,830	7.36	Representativeness
Radionuclide	Water	Calculation Errors	Calculation error	No	1	3,830	0.03	N/A
Radionuclide	Water	Calculation Errors	Calculation error	Yes	1	3,830	0.03	N/A
Radionuclide	Water	Calibration	Calibration counting statistics did not meet criteria	No	14	3,830	0.37	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	No	62	3,830	1.62	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	511	3,830	13.34	Accuracy
Radionuclide	Water	Documentation Issues	Key data fields incorrect	No	1	3,830	0.03	N/A
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	1	3,830	0.03	N/A
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	8	3,830	0.21	N/A
Radionuclide	Water	Documentation Issues	Record added by the validator	Yes	6	3,830	0.16	N/A
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	No	26	3,830	0.68	Representativeness
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	441	3,830	11.51	Representativeness
Radionuclide	Water	Documentation Issues	Transcription error	No	274	3,830	7.15	N/A
Radionuclide	Water	Documentation Issues	Transcription error	Yes	227	3,830	5.93	N/A
Radionuclide	Water	Holding Times	Holding times were exceeded	No	5	3,830	0.13	Representativeness
Radionuclide	Water	Holding Times	Holding times were exceeded	Yes	4	3,830	0.10	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	No	8	3,830	0.21	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	Yes	21	3,830	0.55	Representativeness
Radionuclide	Water	Instrument Set-up	Transformed spectral index external site criteria were not met	No	11	3,830	0.29	Representativeness
Radionuclide	Water	Instrument Set-up	Transformed spectral index external site criteria were not met	Yes	1	3,830	0.03	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	No	7	3,830	0.18	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	Yes	39	3,830	1.02	Representativeness
Radionuclide	Water	LCS	LCS data not submitted by the laboratory	Yes	1	3,830	0.03	Representativeness
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	No	95	3,830	2.48	Accuracy
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	Yes	107	3,830	2.79	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	No	5	3,830	0.13	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	Yes	29	3,830	0.76	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	No	20	3,830	0.52	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Water	LCS	LCS relative percent error criteria not met	Yes	108	3,830	2.82	Accuracy
Radionuclide	Water	Matrices	Recovery criteria were not met	No	7	3,830	0.18	Accuracy
Radionuclide	Water	Matrices	Recovery criteria were not met	Yes	17	3,830	0.44	Accuracy
Radionuclide	Water	Matrices	Replicate analysis was not performed	No	17	3,830	0.44	Precision
Radionuclide	Water	Matrices	Replicate analysis was not performed	Yes	63	3,830	1.64	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	No	25	3,830	0.65	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	Yes	194	3,830	5.07	Precision
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	No	13	3,830	0.34	Accuracy
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	Yes	45	3,830	1.17	Accuracy
Radionuclide	Water	Other	Lab results not verified due to unsubmitted data	No	4	3,830	0.10	Representativeness
Radionuclide	Water	Other	Lab results not verified due to unsubmitted data	Yes	13	3,830	0.34	Representativeness
Radionuclide	Water	Other	Sample exceeded efficiency curve weight limit	Yes	1	3,830	0.03	Accuracy
Radionuclide	Water	Other	Sample results were not validated due to re-analysis	No	1	3,830	0.03	N/A
Radionuclide	Water	Other	See hard copy for further explanation	No	9	3,830	0.23	N/A
Radionuclide	Water	Other	See hard copy for further explanation	Yes	224	3,830	5.85	N/A
Radionuclide	Water	Other	Unit conversion of results	Yes	1	3,830	0.03	N/A
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	Yes	12	3,830	0.31	N/A
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	No	16	3,830	0.42	Representativeness
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	Yes	104	3,830	2.72	Representativeness
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	No	6	3,830	0.16	N/A
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	Yes	1,063	3,830	27.75	N/A
SVOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	30	3,237	0.93	Representativeness
SVOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	8	1,758	0.46	Representativeness
SVOC	Water	Calibration	Continuing calibration verification criteria were not met	No	16	1,758	0.91	Accuracy
SVOC	Water	Documentation Issues	Transcription error	No	63	1,758	3.58	N/A
SVOC	Water	Holding Times	Holding times were exceeded	No	2	1,758	0.11	Representativeness
SVOC	Water	Internal Standards	Internal standards did not meet criteria	No	105	1,758	5.97	Accuracy
SVOC	Water	LCS	LCS recovery criteria were not met	No	20	1,758	1.14	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
SVOC	Water	Other	Sample results were not validated due to re-analysis	No	3	1,758	0.17	N/A
VOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	1	2,314	0.04	Representativeness
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	7	2,314	0.30	Accuracy
VOC	Soil	Documentation Issues	Sample analysis was not requested	No	10	2,314	0.43	N/A
VOC	Soil	Documentation Issues	Sample analysis was not requested	Yes	1	2,314	0.04	N/A
VOC	Soil	Holding Times	Holding times were exceeded	No	34	2,314	1.47	Representativeness
VOC	Soil	Matrices	Percent solids < 30 percent	No	1	2,314	0.04	Representativeness
VOC	Soil	Matrices	Percent solids < 30 percent	Yes	1	2,314	0.04	Representativeness
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	90	17,512	0.51	Representativeness
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	9	17,512	0.05	Representativeness
VOC	Water	Calibration	Continuing calibration verification criteria were not met	No	30	17,512	0.17	Accuracy
VOC	Water	Calibration	Continuing calibration verification criteria were not met	Yes	9	17,512	0.05	Accuracy
VOC	Water	Confirmation	Results were not confirmed	No	9	17,512	0.05	Precision
VOC	Water	Confirmation	Results were not confirmed	Yes	2	17,512	0.01	Precision
VOC	Water	Documentation Issues	Record added by the validator	No	278	17,512	1.59	N/A
VOC	Water	Documentation Issues	Record added by the validator	Yes	3	17,512	0.02	N/A
VOC	Water	Documentation Issues	Transcription error	No	556	17,512	3.17	N/A
VOC	Water	Documentation Issues	Transcription error	Yes	5	17,512	0.03	N/A
VOC	Water	Holding Times	Holding times were exceeded	No	48	17,512	0.27	Representativeness
VOC	Water	Holding Times	Holding times were exceeded	Yes	3	17,512	0.02	Representativeness
VOC	Water	Internal Standards	Internal standards did not meet criteria	No	36	17,512	0.21	Accuracy
VOC	Water	LCS	CRDL check sample recovery criteria were not met	Yes	1	17,512	0.01	Accuracy
VOC	Water	LCS	LCS recovery criteria were not met	No	198	17,512	1.13	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
VOC	Water	LCS	LCS recovery criteria were not met	Yes	2	17,512	0.01	Accuracy
VOC	Water	Other	Sample results were not validated due to re-analysis	No	53	17,512	0.30	N/A
VOC	Water	Other	Sample results were not validated due to re-analysis	Yes	1	17,512	0.01	N/A
VOC	Water	Other	See hard copy for further explanation	Yes	1	17,512	0.01	N/A
Wet Chem	Soil	Holding Times	Holding times were exceeded	No	10	230	4.35	Representativeness
Wet Chem	Soil	Holding Times	Holding times were exceeded	Yes	38	230	16.52	Representativeness
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	20	230	8.70	Accuracy
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	20	230	8.70	Accuracy
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	No	39	2,417	1.61	Representativeness
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	3	2,417	0.12	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	No	17	2,417	0.70	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	Yes	5	2,417	0.21	Representativeness
Wet Chem	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	8	2,417	0.33	Accuracy
Wet Chem	Water	Calibration	Continuing calibration verification criteria were not met	Yes	26	2,417	1.08	Accuracy
Wet Chem	Water	Documentation Issues	Record added by the validator	No	4	2,417	0.17	N/A
Wet Chem	Water	Documentation Issues	Record added by the validator	Yes	5	2,417	0.21	N/A
Wet Chem	Water	Documentation Issues	Transcription error	No	46	2,417	1.90	N/A
Wet Chem	Water	Documentation Issues	Transcription error	Yes	81	2,417	3.35	N/A
Wet Chem	Water	Holding Times	Holding times were exceeded	No	24	2,417	0.99	Representativeness
Wet Chem	Water	Holding Times	Holding times were exceeded	Yes	22	2,417	0.91	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	No	21	2,417	0.87	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	Yes	26	2,417	1.08	Representativeness
Wet Chem	Water	LCS	LCS recovery criteria were not met	No	4	2,417	0.17	Accuracy
Wet Chem	Water	LCS	LCS recovery criteria were not met	Yes	1	2,417	0.04	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Wet Chem	Water	Matrices	Duplicate sample precision criteria were not met	Yes	2	2,417	0.08	Precision
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	No	14	2,417	0.58	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	58	2,417	2.40	Accuracy
Wet Chem	Water	Other	Lab results not verified due to unsubmitted data	No	5	2,417	0.21	Representativeness
Wet Chem	Water	Other	Lab results not verified due to unsubmitted data	Yes	15	2,417	0.62	Representativeness
Wet Chem	Water	Other	See hard copy for further explanation	No	1	2,417	0.04	N/A

Table A2.3
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect	Percent Qualified (%)
Herbicide	Water	5	142	No	3.52
Metal	Soil	518	3,834	No	13.51
Metal	Soil	555	3,834	Yes	14.48
Metal	Water	2,040	14,368	No	14.20
Metal	Water	777	14,368	Yes	5.41
PCB	Water	56	175	No	32.00
Pesticide	Water	217	836	No	25.96
Radionuclide	Soil	1	689	Yes	0.15
Radionuclide	Water	29	3,830	No	0.76
Radionuclide	Water	82	3,830	Yes	2.14
SVOC	Soil	30	3,237	No	0.93
SVOC	Water	133	1,758	No	7.57
VOC	Soil	35	2,314	No	1.51
VOC	Soil	3	2,314	Yes	0.13
VOC	Water	378	17,512	No	2.16
VOC	Water	14	17,512	Yes	0.08
Wet Chem	Soil	10	230	No	4.35
Wet Chem	Soil	58	230	Yes	25.22
Wet Chem	Water	118	2,417	No	4.88
Wet Chem	Water	157	2,417	Yes	6.50
	Total	**5,216**	**51,456**		**10.14%**

Table A2.4
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected Due to Blank Contaimination	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	Soil	17	2,749	0.62
Metal	Water	30	5,580	0.54
	Total	**47**	**8,329**	**0.56%**

[a] As determined by the laboratory prior to V&V.

Table A2.5
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Dioxins and Furans	Water	0	7	0.00	50.00
Herbicide	Water	0	10	0.00	6.54
Metal	Soil	4	169	2.37	4.41
Metal	Water	38	2,209	1.72	13.83
PCB	Water	0	28	0.00	13.79
Pesticide	Water	0	107	0.00	11.62
Radionuclide	Soil	0	34	0.00	4.70
Radionuclide	Water	1	628	0.16	13.84
SVOC	Water	0	297	0.00	15.59
VOC	Water	0	2,719	0.00	14.09
Wet Chem	Soil	2	9	22.22	3.91
Wet Chem	Water	7	361	1.94	13.46

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of V&V Records	Percent Rejected (%)
Dioxins and Furans	Water	0	14	0.00
Herbicide	Soil	2	138	1.45
Herbicide	Water	7	153	4.58
Metal	Soil	105	8,678	1.21
Metal	Water	391	20,280	1.93
PCB	Water	0	196	0.00
Pesticide	Soil	17	138	12.32
Pesticide	Water	1	901	0.11
Radionuclide	Soil	252	1,707	14.76
Radionuclide	Water	575	6,071	9.47
SVOC	Soil	84	8,169	1.03
SVOC	Water	52	1,988	2.62
VOC	Soil	153	5,781	2.65
VOC	Water	862	25,399	3.39
Wet Chem	Soil	8	484	1.65
Wet Chem	Water	122	3,853	3.17
	Total	**2,631**	**83,950**	**3.13%**

Table A2.7
Summary of Data Quality Issues Identified by V&V

Analyte Group	Matrix	Categories Description	V&V Observation	Detect	Percent Observed	Percent Qualified U[a]	Percent Qualified J[b]	PARCC Parameter Affected	Impacts Risk Assessment Decisions
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	11.42	0.00	2.56	Accuracy	No
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	9.42	0.00	9.42	Representativeness	No
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	32.00	0.00	32.00	Accuracy	No
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	24.88	0.00	24.88	Accuracy	No
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	7.36	0.00	1.28	Representativeness	No
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	13.34	0.00	0.26	Accuracy	No
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	11.51	0.00	0.29	Representativeness	No
SVOC	Water	Internal Standards	Internal standards did not meet criteria	No	5.97	0.00	5.97	Accuracy	No
Wet Chem	Soil	Holding Times	Holding times were exceeded	Yes	16.52	0.00	16.52	Representativeness	No
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	8.70	0.00	8.70	Accuracy	No
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	8.70	0.00	8.70	Accuracy	No

[a]Defined as validation qualifier codes containing "U"

[b]Defined as validation qualifier codes containing "J", except "UJ"

COMPREHENSIVE RISK ASSESSMENT

INTER-DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 3

Statistical Analyses and Professional Judgment

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
IDEU	Inter-Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
tESL	threshold ESL
UCL	upper confidence limit

UTL	upper tolerance limit
WRS	Wilcoxon Rank Sum
WRW	wildlife refuge worker

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Inter-Drainage Exposure Unit (EU) (IDEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE INTER-DRAINAGE EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the IDEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.26.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the interquartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations in the IDEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the IDEU that are statistically greater than background (or those where background comparisons were not performed) are carried

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the IDEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

through to the upper-bound exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the IDEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits on the mean (UCLs) for arsenic exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs), and this PCOC was carried forward into the statistical background comparison step. The results of the statistical comparison of the IDEU surface soil/surface sediment data to background data for these PCOCs are presented in Table A3.2.1 and the summary statistics for background and IDEU surface soil/surface sediment data are shown in Table A3.2.2. The IDEU MDC for aluminum and manganese exceed the PRG, but the UCL for the IDEU data set does not exceed the PRG, and these analytes were not evaluated further. The MDC and UCL for arsenic exceed the PRG and were carried forward into the statistical background comparison step.

The results of the statistical comparisons of the IDEU surface soil/surface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison Not Performed[1]

- None

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

The MDC and UCL for radium-228 exceed the PRG for the IDEU subsurface soil/subsurface sediment data set and were carried forward into the statistical background comparison step. The results of the statistical comparison of the IDEU subsurface soil/subsurface sediment data to the background data are presented in Table A3.2.3 and the summary statistics for the IDEU subsurface soil/subsurface sediment data to background data are presented in Table A3.2.4.

The results of the statistical comparisons of the IDEU subsurface soil/subsurface data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison not Performed[1]

- None

2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors)

For the ECOIs in surface soil, the MDCs for aluminum, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, tin, vanadium, and zinc exceed a non-PMJM ESL, and these ECOIs were carried forward into the statistical background comparison step. The results of the statistical comparison of the IDEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and IDEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the IDEU surface soil to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Arsenic
- Barium
- Chromium
- Lead
- Lithium
- Manganese

Not Statistically Greater than Background at the 0.1 Significance Level

- Cadmium
- Copper
- Mercury

- Nickel
- Vanadium
- Zinc

Background Comparison not Performed[1]

- Antimony
- Boron
- Molybdenum
- Tin

2.4 Surface Soil Data used in the ERA (PMJM Receptors)

For the ECOIs in surface soil in PMJM habitat, the MDCs for arsenic, manganese, nickel, selenium, vanadium, and zinc exceed the PMJM ESLs, and were carried forward into the background comparison step. The results of the statistical comparison of the IDEU surface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and IDEU surface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the IDEU surface soil in PMJM habitat to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Manganese
- Nickel
- Selenium
- Vanadium
- Zinc

Background Comparison not Performed[1]

- None

2.5 Subsurface Soil Data used in the ERA

For the ECOIs in subsurface soil, the MDC for arsenic, mercury, nickel, and vanadium exceed the prairie dog ESL and were carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ESL. The results of the statistical comparison of the IDEU subsurface soil data to background data are presented in Table A3.2.9 and the summary statistics for background and IDEU subsurface soil data are shown in Table A3.2.10.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Nickel
- Vanadium

Background Comparison not Performed[1]

- Mercury

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background, or if background comparisons were not performed, are evaluated further by comparing the IDEU EPCs to the limiting tESLs. The EPCs are the 95 percent UCLs of the 90th percentile (upper tolerance limit [UTL]) for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOIs in Surface Soil

Barium, manganese and molybdenum in surface soil (non-PMJM) were eliminated from further consideration because the upper-bound EPCs are not greater than the tESLs. Aluminum, antimony, arsenic, boron, chromium, lead, lithium, and tin have upper-bound EPCs greater than the tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

Mercury in subsurface soil was eliminated from further consideration because the upper-bound EPC is not greater than the tESL. There are no analytes carried forward into professional judgment for subsurface soils.

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above is included in the discussion.

[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states provides regional benchmarks for naturally-occurring metals in soil. The comparison of RFETS's soil data to these regional benchmarks is only performed for non-PMJM professional judgment because the PMJM habitat is restricted to the front range of Colorado.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for IDEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
- Subsurface soil/subsurface sediment (HHRA)
  - No PCOCs were found to be statistically greater than background and above a PRG in accordance with the COC selection process; therefore, no PCOCs in subsurface soil/subsurface sediment are evaluated using professional judgment.
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Antimony
  - Arsenic
  - Boron
  - Chromium
  - Lead
  - Lithium
  - Tin
- Surface soil for PMJM receptors (ERA)
  - No ECOIs were found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process; therefore, no ECOIs in surface soil in PMJM habitat areas are evaluated using professional judgment.
- Subsurface soil (ERA)
  - No ECOIs were found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process; therefore, no ECOIs in subsurface soil are evaluated using professional judgment

The following sections provide the professional judgment evaluations, by analyte and by medium, for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates there is a potential for aluminum to have been released into the RFETS soil because of the large historical aluminum metal inventory at RFETS and presence of aluminum in waste generated during former operations. However, these operations occurred in the former Industrial Area which is remote from the IDEU.

4.1.2 Evaluation of Spatial Trends

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in IDEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for aluminum indicates a single background population ranging from 7,340 to 19,400 mg/kg, but with three apparently anomalously high concentration samples. Because the spatial trend analysis indicates that aluminum concentrations in IDEU surface soil reflect variations in naturally occurring aluminum, and the IDEU concentrations are similar to RFETS background levels and are well within regional background levels (see Section 4.1.4), the three samples may simply have a higher clay content than those representing the background population (Figure A3.4.1).

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum concentrations in IDEU surface soil range from 7,340 to 35,000 mg/kg, with a mean concentration of 13,234 mg/kg and a standard deviation of 5,151 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6). The maximum concentrations of aluminum in surface soil samples at the IDEU are elevated compared to background but the data populations overlap considerably.

Aluminum concentrations IDEU surface soil are well within the range for aluminum in soils of Colorado and the bordering states (5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg) (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the IDEU (35,000 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (50 mg/kg). However, EPA ecological soil screening level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Therefore, aluminum concentrations in IDEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in IDEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, have a spatial distribution and single data population indicative of naturally occurring aluminum, are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the IDEU and, therefore, is not further evaluated quantitatively.

4.2 Antimony

Antimony has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if antimony should be retained for risk characterization are summarized below. Antimony was not detected in background surface soils; therefore, the subsections discussing comparisons to background data sets and risk potential are not included here.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates antimony is unlikely to be present in IDEU soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, several locations have antimony concentrations in IDEU that are greater than the ESL and the background MDC that are located near a historical IHSS.

4.2.3 Conclusion

Antimony in surface soil is being carried forward into the ecological non-PMJM risk characterization because of elevated concentrations (greater than three times the ESL), and because antimony is at nondetectable concentrations for the background data set. Antimony was used in limited quantities during historical RFETS operations, which would indicate that it is unlikely to be a site-related contaminant. Nevertheless, as a conservative measure, antimony is carried forward into the risk characterization recognizing that the classification as a COC/ECOPC is uncertain.

4.3 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. Arsenic also has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in IDEU soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in IDEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in IDEU subsurface soil reflect variations in naturally occurring arsenic.

4.3.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for arsenic does not suggests a single background because of four anomalously high samples (Figure A3.4.2).

Surface Soil (Non-PMJM)

The probability plot for arsenic does not suggests a single background because of four anomalously high samples (Figure A3.4.3.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic concentrations in IDEU surface soil/surface sediment range from 4.00 to 17.0 mg/kg, with a mean concentration of 7.78 mg/kg and a standard deviation of 1.90 mg/kg. Arsenic concentrations in the background data set range from 0.27 to 9.60 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2). The range of concentrations of arsenic in the IDEU and background samples overlap considerably with only four of the 64 detections greater than the background MDC (9.6 mg/kg).

Arsenic concentrations IDEU surface soil/surface sediment are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

Surface Soil (Non-PMJM)

Arsenic concentrations in IDEU surface soil range from 4.00 to 17.0 mg/kg, with a mean concentration of 7.78 mg/kg and a standard deviation of 1.90 mg/kg. Arsenic concentrations in the background data set range from 2.30 to 9.60 mg/kg, with a mean concentration of 6.09 mg/kg and a standard deviation of 2.00 mg/kg (Table A3.2.6). The range of concentrations of arsenic in the IDEU and background samples overlap considerably with only four of the 64 detections greater than the background MDC (9.6 mg/kg).

Arsenic concentrations IDEU surface soil are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

4.3.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 17.0 mg/kg and the UCL is 8.18 mg/kg. The UCL is less than three times greater than the PRG (2.41 mg/kg), with all of the 64 detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 3E-06, and is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Arsenic is detected in 67 of 73 background samples, and concentrations in 39 of the 67 samples with detects exceed the PRG. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Volume 2, Attachment 9 of the RI/FS

Report), which equates to a cancer risk of 2E-06. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the IDEU are similar to background risk.

4.3.6 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for arsenic (12.0 mg/kg) in IDEU surface soil for non-PMJM receptors exceeds the NOAEL ESL for terrestrial plants (10 mg/kg), deer mouse herbivore (2.57 mg/kg), and prairie dog (9.35 mg/kg). However, the UTL and the MDC (17.0 mg/kg) are less than the Eco-SSL for plants (18 mg/kg), birds (43 mg/kg) and mammals (46 mg/kg) (EPA 2005a). In addition, arsenic concentrations in IDEU surface soil have a similar range as the background concentrations and are most likely due to local variations in natural sources.

4.3.7 Conclusion

Although the probability plots do not suggest the presence of a single background population, the weight of evidence presented above shows that arsenic concentrations in IDEU surface soil/surface sediment and surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution indicative of naturally occurring arsenic, and concentrations that are well within regional background levels. Arsenic is not considered a COC in surface soil/surface sediment or an ECOPC in surface soil (non-PMJM receptors) for the IDEU and, therefore, is not further evaluated quantitatively.

4.4 Boron

For boron in surface soil, a statistical comparison between IDEU and RFETS background data could not be performed because RFETS background surface soil samples were not analyzed for boron. Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.4.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in IDEU surface soil reflect variations in naturally occurring boron.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for boron concentrations indicates a single background population (Figure A3.4.4).

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg. Boron concentrations reported in surface soil samples at the IDEU range from 4.30 to 9.70 mg/kg, with a mean concentration of 5.64 mg/kg and a standard deviation of 2.19 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the range for boron in soils of Colorado and the bordering states.

4.4.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for boron in the IDEU (9.7 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 30.3 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Table A3.4.1. This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the IDEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. No boron Eco-SSLs are currently available for plants or any other receptor. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is highly unlikely to present a risk to terrestrial receptor populations in the IDEU.

4.4.6 Conclusion

The weight of evidence presented above shows that boron concentrations in IDEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, have a spatial distribution and single data population indicative of naturally occurring boron, are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the IDEU and, therefore, is not further evaluated quantitatively.

4.5 Chromium

Chromium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if chromium should be retained for risk characterization are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates there is a potential for chromium to have been released into the RFETS soil because of the moderate historical chromium metal inventory at RFETS and presence of chromium in waste generated during former operations. However, these operations occurred in the former Industrial Area which is remote from the IDEU.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Attachment 8 of Volume 2, chromium concentrations in the IDEU appear to be variations in naturally occurring chromium.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for chromium indicates two populations: an apparent background population ranging from 9.3 to 12.7 mg/kg and a second population ranging from 13.1 to 26 mg/kg (Figure A3.4.5). However, the IDEU concentration range is similar to RFETS background levels.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Chromium concentrations in surface soil samples at the IDEU range from 9.30 to 26.0 mg/kg, with a mean concentration of 13.7 mg/kg and a standard deviation of

3.83 mg/kg. Chromium concentrations in the background data set range from 5.50 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.6). The maximum concentrations of chromium in surface soil samples at the IDEU are elevated compared to background but the data populations do overlap considerably.

Chromium concentrations reported in surface soil samples at the IDEU are well within the range for chromium in soils of Colorado and the bordering states (3 to 500 mg/kg, with mean concentration of 48.2 mg/kg and a standard deviation of 41 mg/kg) (Table A3.4.1).

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for chromium in the IDEU (22.7 mg/kg) exceeds the NOAEL ESL for terrestrial plants (1 mg/kg), terrestrial invertebrates (0.4 mg/kg), mourning dove insectivore (1.34 mg/kg), American kestrel (14.0 mg/kg) and deer mouse insectivore (15.9 mg/kg). All of these ESLs are less than the MDC in background surface soils. All other NOAEL ESLs were greater than the UTL and ranged from 68.5 to 4,170 mg/kg. The UTL is also less than the EPA Eco-SSLs for birds (26 mg/kg) and mammals (34 mg/kg), that are based on chromium III (EPA 2005b). An EPA EcoSSL based on chromium VI is not available for birds but is equal to 81 mg/kg for mammals (EPA 2005b). The chromium ESLs are based on toxicity to hexavalent chromium, of which is likely to represent only a small fraction of the total chromium detected in soils. The mammalian ESLs for trivalent chromium are considerably greater than the hexavalent chromium ESLs. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to plants and wildlife.

4.5.6 Conclusion

Although the probability plot does not suggests the presence of a single background population, the weight of evidence presented above shows that chromium concentrations in IDEU surface soil (non-PMJM receptors) are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact chromium concentrations in surface soil. Chromium is not considered an ECOPC in surface soil for the IDEU and is not further evaluated quantitatively.

4.6 Lead

Lead has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lead should be retained for risk characterization are summarized below.

4.6.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates lead was used in relatively large quantities, but was extremely limited in scope or duration. Lead waste was generated in both laboratory and process wastes.

4.6.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lead concentrations in IDEU surface soil cannot be eliminated as an ECOPC for the IDEU because lead concentrations in surface soil are greater than the minimum ESL and greater than the background MDC at locations near historical IHSSs.

4.6.3 Conclusion

Lead in surface soil is being carried forward into the ecological non-PMJM risk characterization because of elevated concentrations (greater than three times the ESL) and because lead waste was generated in both laboratory and process buildings. Lead was used in large quantities during historical RFETS operations, but in extremely limited scope or duration. Therefore, as a conservative measure, lead is carried forward into the risk characterization recognizing that their classification as COCs/ECOPCs is uncertain.

4.7 Lithium

Lithium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained as a COC are summarized below.

4.7.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for lithium to be a COC in the IDEU is low due to a small inventory, no record of spills, limited identification as a constituent in wastes generated at RFETS, and localized documented historical source areas remote from the IDEU.

4.7.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, lithium concentrations in the IDEU appear to be variations of naturally occurring conditions.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for lithium concentrations indicates a single background population (Figure A3.4.6).

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium concentrations in surface soil samples at the IDEU range from 5.50 to 19.4 mg/kg, with a mean concentration of 10.2 mg/kg and a standard deviation of 2.94 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean concentration of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). The maximum concentrations of lithium in surface soil samples at the IDEU are elevated compared to background but the data populations do overlap considerably.

Lithium concentrations reported in surface soil samples at the IDEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the IDEU (16.0 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,400 mg/kg. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997) cited no observed adverse effects at 25 mg/kg, which is greater than the UTL. No lithium Eco-SSLs are currently available for any receptor. Lithium concentrations in IDEU surface soil have a similar range as the background concentrations and are most likely due to local variations in natural sources and are below available ESLs for vertebrate receptors. The ESL for terrestrial plants is also lower than all detected background concentrations.

4.7.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in surface soil in the IDEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact lithium concentrations in surface soil. In addition, the maximum concentrations of lithium in surface soil samples at the IDEU are elevated compared to background but the data populations do overlap considerably. Lithium is not

considered an ECOPC in surface soil for the IDEU and is not further evaluated quantitatively.

4.8 Tin

For tin in surface soil, a statistical comparison between IDEU and RFETS background data could not be performed because tin was not detected in RFETS background surface soil samples. Tin had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step pursuant with the Comprehensive Risk Assessment (CRA) Methodology (DOE 2005). The lines of evidence used to determine if tin should be retained as a COC are summarized below.

4.8.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for tin to be a COC in the IDEU is low due to localized documented historical source areas remote from the IDEU.

4.8.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, tin concentrations in the IDEU appear to be variations of naturally occurring conditions.

4.8.3 Pattern Recognition

Surface Soil (Non-PMJM)

Figure A3.4.7 is a probability plot that contains both the detected and nondetected tin concentrations in the 64 soil samples from this EU. It appears to represent a single background population, even though the RFETS background summary statistics for the IDEU tin concentration are considerably different.

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for tin in surface soil within Colorado and the bordering states is 0.117 to 5.001 mg/kg, with a mean concentration of 1.15 mg/kg and a standard deviation of 0.772 mg/kg (Table A3.4.1). Tin concentrations reported as detected in surface soil samples at the IDEU are 2.40 to 4.90 mg/kg, with a mean concentration of 1.82 mg/kg and a standard deviation of 1.02 mg/kg (Table A3.2.6). The range of concentrations of tin in surface soil is within the range for tin in soils of Colorado and the bordering states (Table A3.2.6). Tin was not detected in the RFETS background data set.

4.8.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for tin in the IDEU (4.1 mg/kg) exceeds the NOAEL ESL for two receptor groups: mourning dove insectivore (2.9 mg/kg) and deer mouse insectivore (3.77 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 16.2 to 242 mg/kg. No tin Eco-SSLs are currently available for any receptor.

4.8.6 Conclusion

The weight of evidence presented above shows that tin concentrations in surface soil in the IDEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact tin concentrations in surface soil. Tin is not considered an ECOPC in surface soil for the IDEU and is not further evaluated quantitatively.

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TABLES

Table A3.2.1
Statistical Distribution and Comparison to Background for IDEU Surface Soil/ Surface Sediment

	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set (excluding background samples)					
Analyte	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**73**	**GAMMA**	**91.8**	**64**	**NON-PARAMETRIC**	**100.00**	**WRS**	**7.00E-5**	**No**

WRS = Wilcoxon Rank Sum Text.

Bold = PCOCs retained for further consideration in the next COC selection step.

Table A3.2.2

Summary Statistics for Background and IDEU Surface Soil/Surface Sediments[a]

Analyte	Units	Background					IDEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	64	4.00	17.0	7.78	1.90

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.3
Statistical Distribution and Comparison to Background for IDEU Subsurface Soil/Subsurface Sediment

	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set (excluding background samples)					
Analyte	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Radium-228	**31**	**GAMMA**	**100.0**	**4**	**NORMAL**	**100.00**	**WRS**	**0.960**	**No**

WRS = Wilcoxon Rank Sum Text.
Bold = PCOCs retained for further consideration in the next COC selection step.

Table A3.2.4
Summary Statistics for Background and IDEU Subsurface Soil/Subsurface Sediments

		Background					IDEU (excluding background samples)				
Analyte	**Units**	**Total Samples**	**Minimum Detected Concentration**	**Maximum**	**Mean**	**Standard Deviation**	**Total Samples**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Radium-228	pCi/g	31	1.00	2.10	1.45	0.320	4	0.890	1.35	1.00	0.193

* For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

Table A3.2.5
Statistical Distribution and Comparison to Background for IDEU Surface Soil (non-PMJM)

	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set (excluding background samples)					
Analyte	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	0.005	Yes
Antimony	20	NON-PARAMETRIC	0.0	64	NON-PARAMETRIC	14.06	N/A	N/A	N/A
Arsenic	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	7.40E-04	Yes
Barium	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	3.65E-05	Yes
Boron	N/A	N/A	N/A	14	NORMAL	78.57	N/A	N/A	N/A
Cadmium	20	NON-PARAMETRIC	65.0	64	NON-PARAMETRIC	42.19	WRS	0.959	No
Chromium	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	0.008	Yes
Copper	20	NON-PARAMETRIC	100.0	64	NON-PARAMETRIC	100.00	WRS	0.978	No
Lead	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	0.010	Yes
Lithium	20	NORMAL	100.0	64	GAMMA	100.00	WRS	1.88E-04	Yes
Manganese	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	4.03E-04	Yes
Mercury	20	NON-PARAMETRIC	40.0	64	NON-PARAMETRIC	21.88	WRS	0.998	No
Molybdenum	20	NORMAL	0.0	64	NON-PARAMETRIC	37.50	N/A	N/A	N/A
Nickel	20	NORMAL	100.0	64	LOGNORMAL	100.00	WRS	0.759	No
Tin	20	NORMAL	0.0	64	NON-PARAMETRIC	21.88	N/A	N/A	N/A
Vanadium	20	NORMAL	100.0	64	NON-PARAMETRIC	100.00	WRS	0.123	No
Zinc	20	NORMAL	100.0	64	GAMMA	100.00	WRS	0.998	No

WRS = Wilcoxon Rank Sum Text.
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = PCOCs retained for further consideration in the next COC selection step.

Table A3.2.6
Summary Statistics for Background and IDEU Surface Soil (non-PMJM)[a]

Analyte	Units	Background					IDEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	64	7,340	35,000	13,234	5,151
Antimony	mg/kg	20	N/A	N/A	0.279	0.078	64	0.330	3.50	1.39	0.923
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	64	4.00	17.0	7.78	1.90
Barium	mg/kg	20	45.7	134	102	19.4	64	62.0	199	124	21.8
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	14	4.30	9.70	5.64	2.19
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	64	0.600	1.40	0.484	0.363
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	64	9.30	26.0	13.7	3.83
Copper	mg/kg	20	5.20	16.0	13.0	2.58	64	5.30	88.1	13.4	9.87
Lead	mg/kg	20	8.60	53.3	33.5	10.5	64	9.50	82.9	39.9	13.3
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	64	5.50	19.4	10.2	2.94
Manganese	mg/kg	20	129	357	237	63.9	64	45.0	558	300	78.2
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	64	0.009	0.038	0.045	0.014
Molybdenum	mg/kg	20	N/A	N/A	0.573	0.184	64	0.360	2.60	0.768	0.448
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	64	5.10	32.0	9.86	4.50
Tin	mg/kg	20	N/A	N/A	2.06	0.410	64	2.40	4.90	1.82	1.02
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	64	23.0	71.0	31.1	8.20
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	64	23.0	70.0	42.7	9.12

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.7
Statistical Distribution and Comparison to Background for IDEU Surface Soil (PMJM)

	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			IDEU Data Set (excluding background samples)					
Analyte	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	20	NORMAL	100	7	GAMMA	100	WRS	0.925	No
Manganese	20	NORMAL	100	7	NORMAL	100	t-Test_N	0.203	No
Nickel	20	NORMAL	100	7	NORMAL	100	t-Test_N	0.898	No
Selenium	20	NON-PARAMETRIC	60	7	NORMAL	43	WRS	0.994	No
Vanadium	20	NORMAL	100	7	NORMAL	100	t-Test_N	0.621	No
Zinc	20	NORMAL	100	7	LOGNORMAL	100	WRS	0.988	No

WRS = Wilcoxon Rank Sum.
t-Test_N = Student's t-test using normal data.

Table A3.2.8

Summary Statistics for Background and IDEU Surface Soil (PMJM)[a]

Analyte	Units	Background					IDEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	7	1.50	7.60	4.30	2.90
Manganese	mg/kg	20	129	357	237	63.9	7	96.1	556	272	152
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	7	4.50	10.7	8.17	2.14
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	7	0.450	0.580	0.369	0.161
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	7	11.8	42.0	26.6	9.89
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	7	17.5	138	44.8	42.1

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.9
Statistical Distribution and Comparison to Background for IDEU Subsurface Soil

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			IDEU Data Set (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	mg/kg	45	NON-PARAMETRIC	93.3	72	GAMMA	100.00	WRS	0.544	No
Mercury	mg/kg	41	NON-PARAMETRIC	29.3	72	NON-PARAMETRIC	19.44	N/A	N/A	N/A
Nickel	mg/kg	44	GAMMA	100.0	72	GAMMA	84.72	WRS	1.000	No
Vanadium	mg/kg	45	NORMAL	97.8	72	NON-PARAMETRIC	98.61	WRS	1.000	No

WRS = Wilcoxon Rank Sum.
N/A = Not applicable; site and/or background detection frequency less than 20%.
t-Test_N = Student's t-test using normal data.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.10
Summary Statistics for Background and IDEU Subsurface Soil

Analyte	Units	Background					IDEU (excluding background samples)				
		Total Samples	Minimum	Maximum	Mean	Standard Deviation	Total Samples	Minimum	Maximum	Mean	Standard Deviation
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	72	1.30	16.0	4.79	2.46
Mercury	mg/kg	41	0.190	0.640	0.155	0.166	72	0.047	25.4	0.413	2.99
Nickel	mg/kg	44	4.30	54.2	20.9	11.1	72	1.40	49.0	11.0	7.93
Vanadium	mg/kg	45	11.4	70.0	33.8	14.8	72	6.10	91.9	25.0	13.7

[a] Statistics are computed using one-half of the report values for nondetects.

Table A3.4.1
Summary of Element Concentrations in Colorado and Bordering States Soils

Analyte	Total Number of Results	Number of Nondetects	Detection Frequency (%)	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Range of Detected Values (mg/kg)	Average Detected Value (mg/kg)[c]	Standard Deviation (mg/kg)[c]
Aluminum	335		100%	10.0	100,000	10 - 100,000	45,900	26,900
Antimony	84	71	15%	1.04	2.53	1.038 - 2.531	0.647	0.378
Arsenic	307	2	99%	1.22	97.0	1.224 - 97	6.90	7.64
Barium	342		100%	100	3,000	100 - 3,000	642	330
Beryllium	342	219	36%	1.00	7.00	1 - 7	0.991	0.876
Boron	342	114	67%	20.0	150	20 - 150	27.9	19.7
Bromine	85	42	51%	0.504	3.52	0.5038 - 3.522	0.681	0.599
Calcium	342		100%	0.055	32.0	0.055 - 32	3.09	4.13
Carbon	85		100%	0.300	10.0	0.3 - 10	2.18	1.92
Cerium	291	244	16%	150	300	150 - 300	90.0	38.4
Chromium	342		100%	3.00	500	3 - 500	48.2	41.0
Cobalt	342	39	89%	3.00	30.0	3 - 30	8.09	5.03
Copper	342		100%	2.00	200	2 - 200	23.1	17.7
Fluorine	264	7	97%	10.0	1,900	10 - 1900	394	261
Gallium	340	3	99%	5.00	50.0	5 - 50	18.3	8.90
Germanium	85		100%	0.578	2.15	0.5777 - 2.146	1.18	0.316
Iodine	85	18	79%	0.516	3.49	0.516 - 3.487	1.07	0.708
Iron	342		100%	3,000	100,000	3,000 - 100,000	21,100	13,500
Lanthanum	341	115	66%	30.0	200	30 - 200	39.8	28.8
Lead	342	25	93%	10.0	700	10 - 700	24.8	41.5
Lithium	307		100%	5.00	130	5 - 130	25.3	14.4
Magnesium	342		100%	300	100,000	300 - 100,000	8,890	8,080
Manganese	342		100%	70.0	2,000	70 - 2,000	414	272
Mercury	309	3	99%	0.010	4.60	0.01 - 4.6	0.077	0.276
Molybdenum	340	328	4%	3.00	7.00	3 - 7	1.59	0.522
Neodymium	256	198	23%	70.0	300	70 - 300	47.1	31.7
Nickel	342	12	96%	5.00	700	5 - 700	18.8	39.8
Niobium	335	123	63%	10.0	100	10 - 100	11.4	8.68
Phosphorus	249		100%	40.0	4,497	40 - 4497	399	397
Potassium	341		100%	1,900	63,000	1,900 - 63,000	18,900	6,980
Rubidium	85		100%	35.0	140	35 - 140	75.8	25.0
Scandium	342	51	85%	5.00	30.0	5 - 30	8.64	4.69
Selenium	309	60	81%	0.102	4.32	0.1023 - 4.3183	0.349	0.415
Silicon	85		100%	149,340	413,260	149340 - 413260	302,000	61,500
Sodium	335		100%	500	70,000	500 - 70,000	10,400	6,260
Strontium	342		100%	10.0	2,000	10 - 2,000	243	212
Sulfur	85	71	16%	816	47,760	816 - 47,760	1,250	5,300
Thallium	76		100%	2.45	20.8	2.45 - 20.79	9.71	3.54
Tin	85	3	96%	0.117	5.00	0.117 - 5.001	1.15	0.772
Titanium	342		100%	500	7,000	500 - 7,000	2,290	1,350
Uranium	85		100%	1.11	5.98	1.11 - 5.98	2.87	0.883
Vanadium	342		100%	7.00	300	7 - 300	73.0	41.7
Ytterbium	330	3	99%	1.00	20.0	1 - 20	3.33	2.06
Yttrium	342	7	98%	10.0	150	10 - 150	26.9	18.1
Zinc	330		100%	10.0	2,080	10 - 2,080	72.4	159
Zirconium	342		100%	30.0	1,500	30 - 1,500	220	157

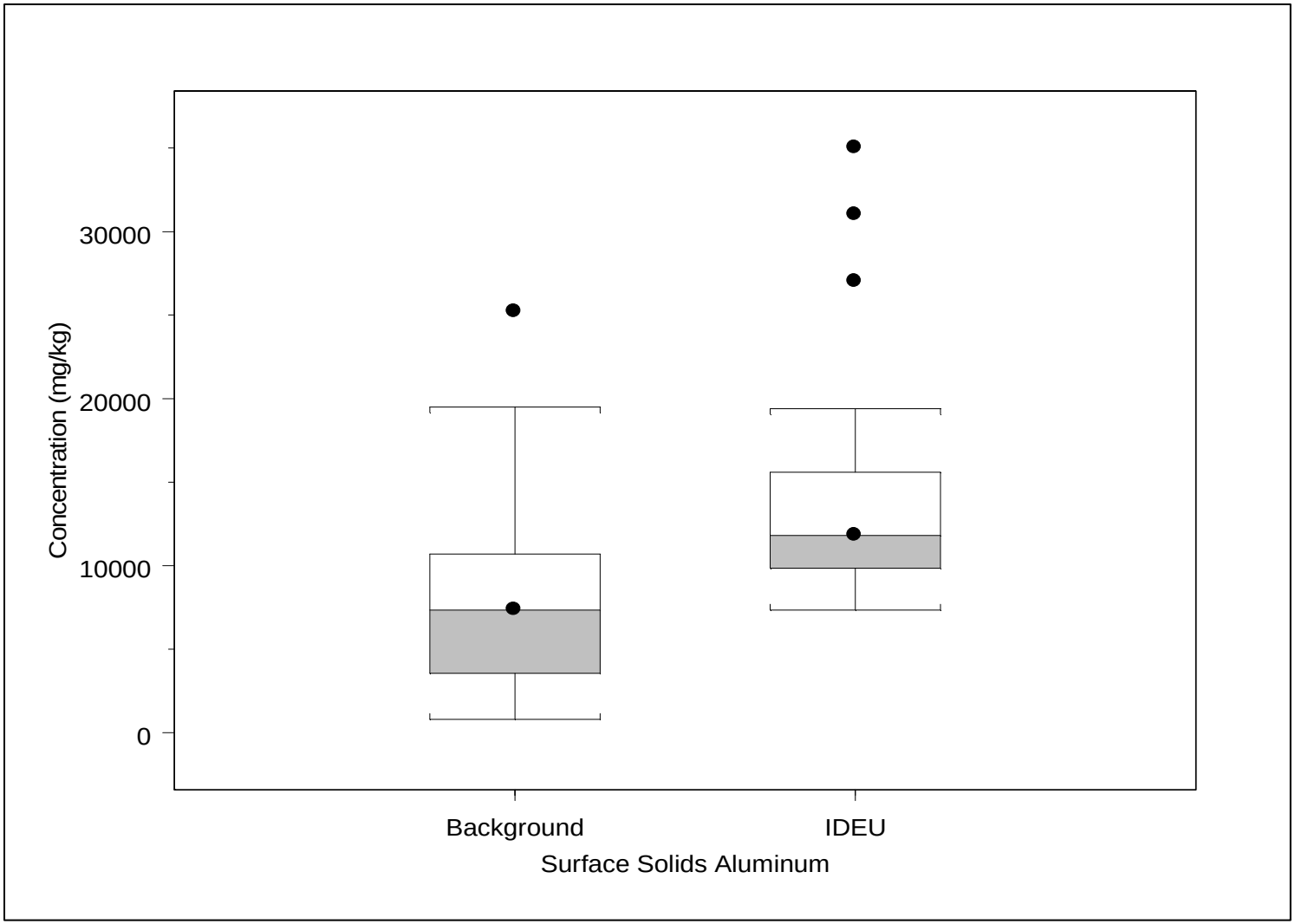
[a] The western U.S. background data set (Shacklette and Boerngen 1984) is composed of background values from Colorado, as well as all states bordering Colorado (Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming). See Section 4.0.

[b] The element was measured at a concentration greater than the upper determination limit for the technique.

[c] Average and standard deviation values were calculated using one-half the reported value for nondetects.

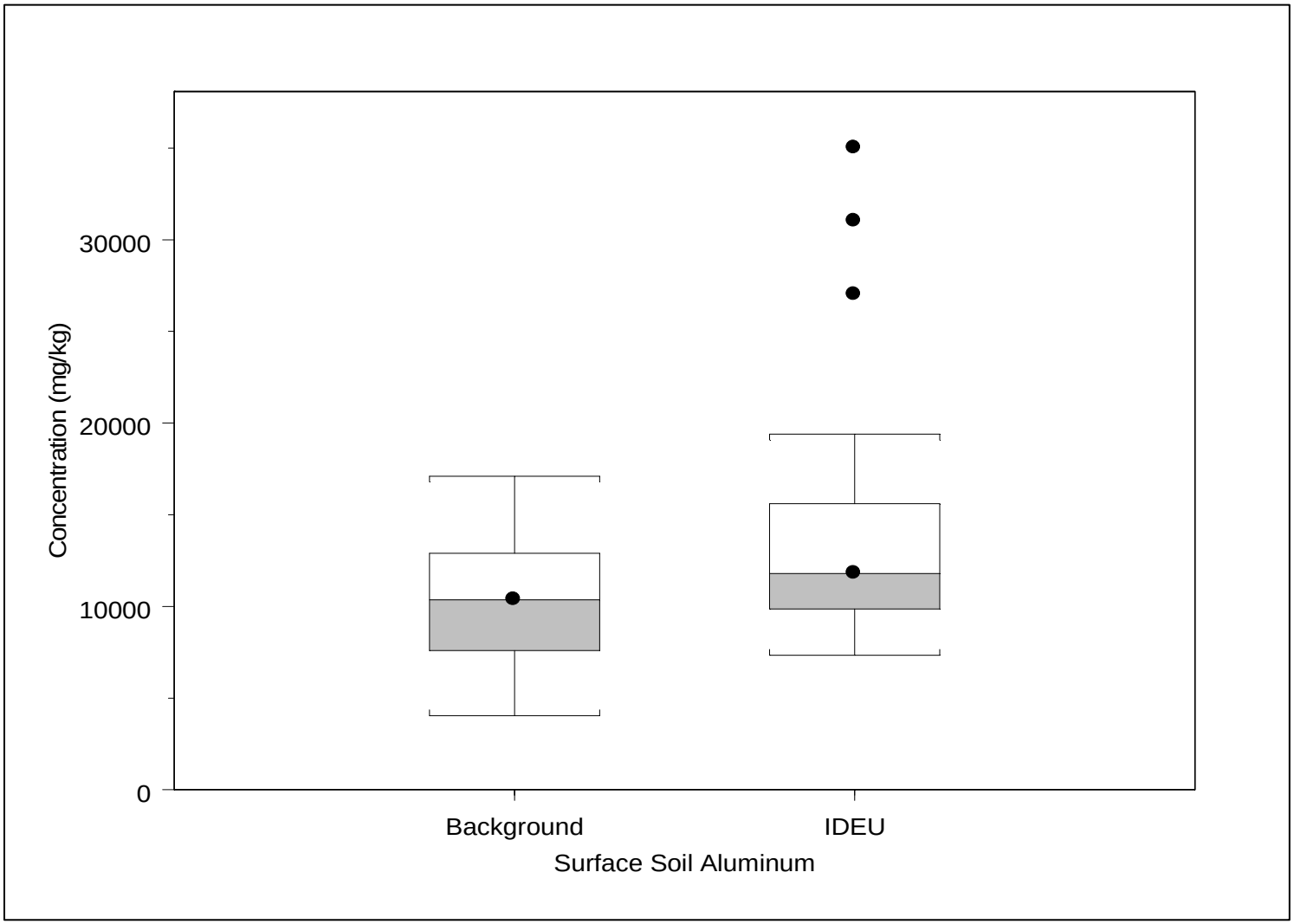
FIGURES

Figure A3.2.1
IDEU Surface Soil/Surface Sediment Box Plots for Aluminum



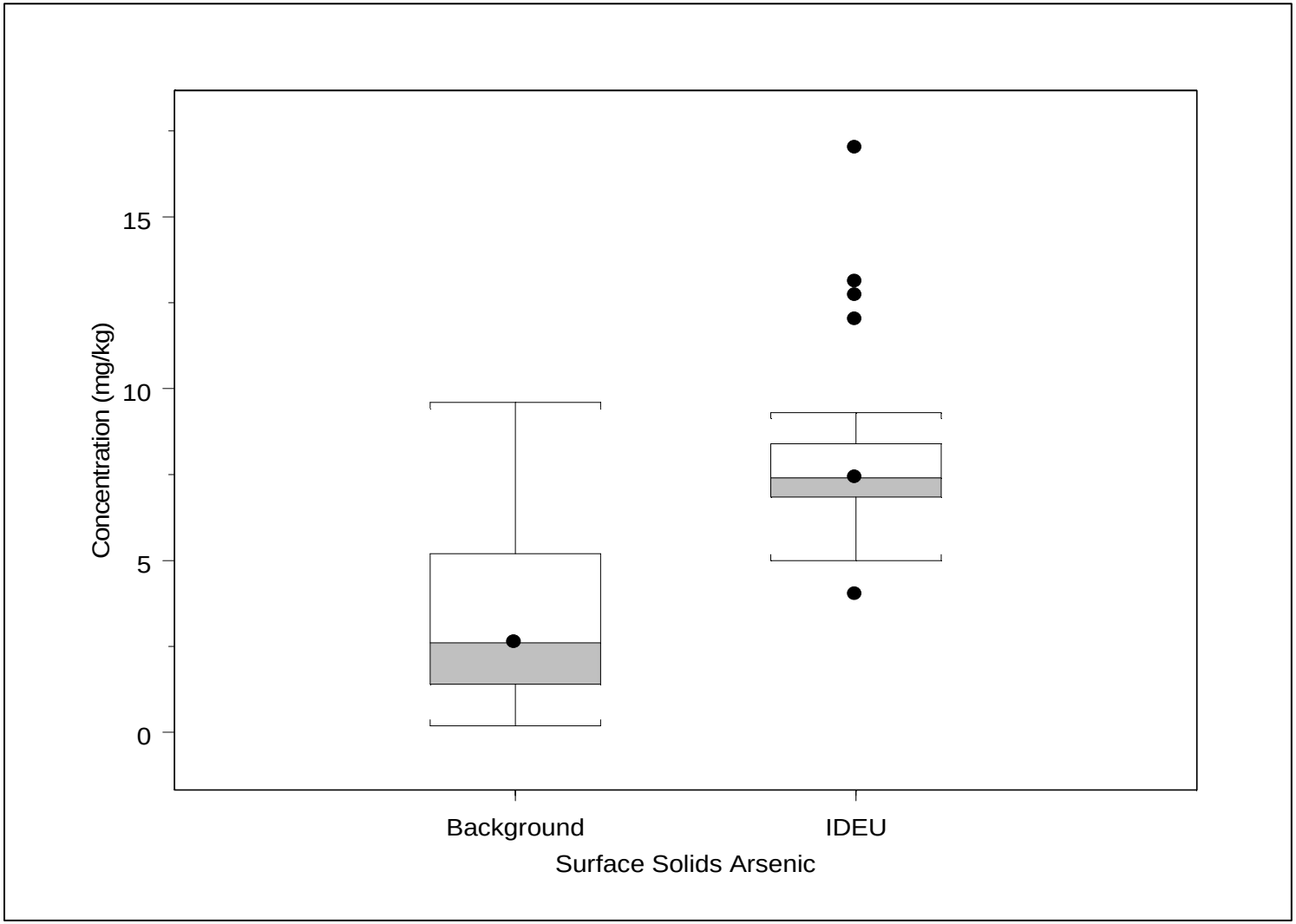
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.2
IDEU Surface Soil (Non-PMJM) Box Plots for Aluminum



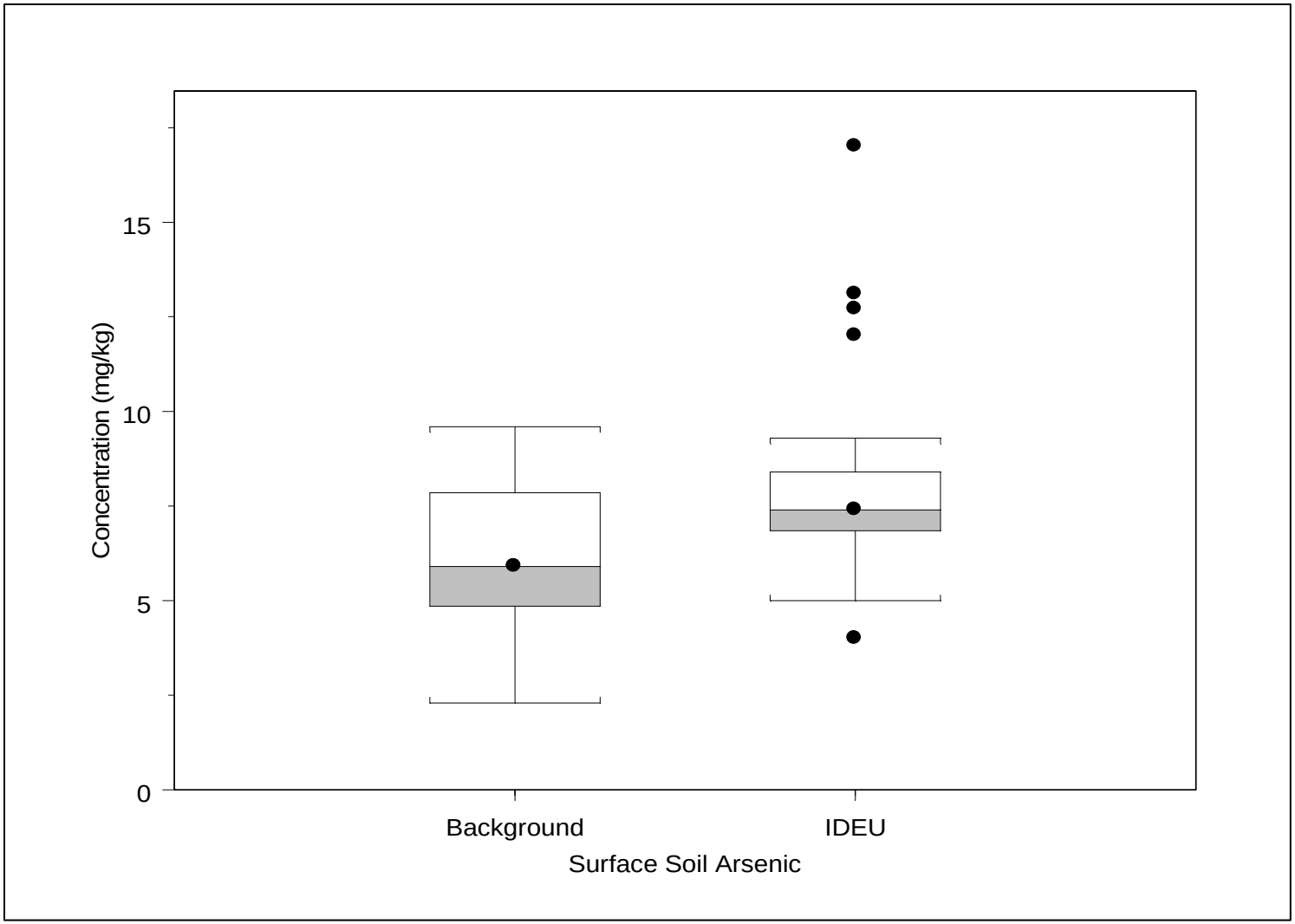
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3
IDEU Surface Soil/Surface Sediment Box Plots for Arsenic



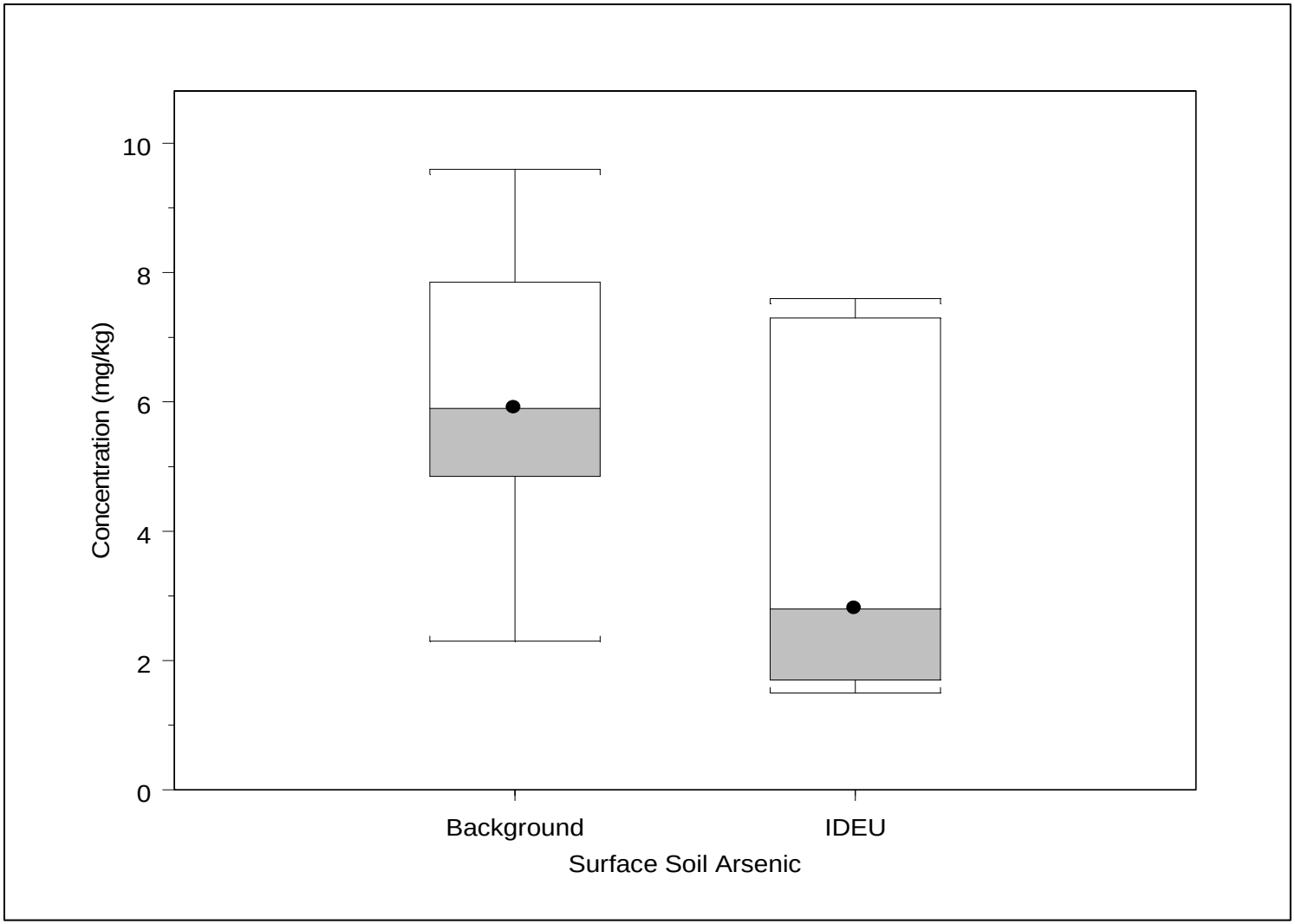
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.4
IDEU Surface Soil (Non-PMJM) Box Plots for Arsenic



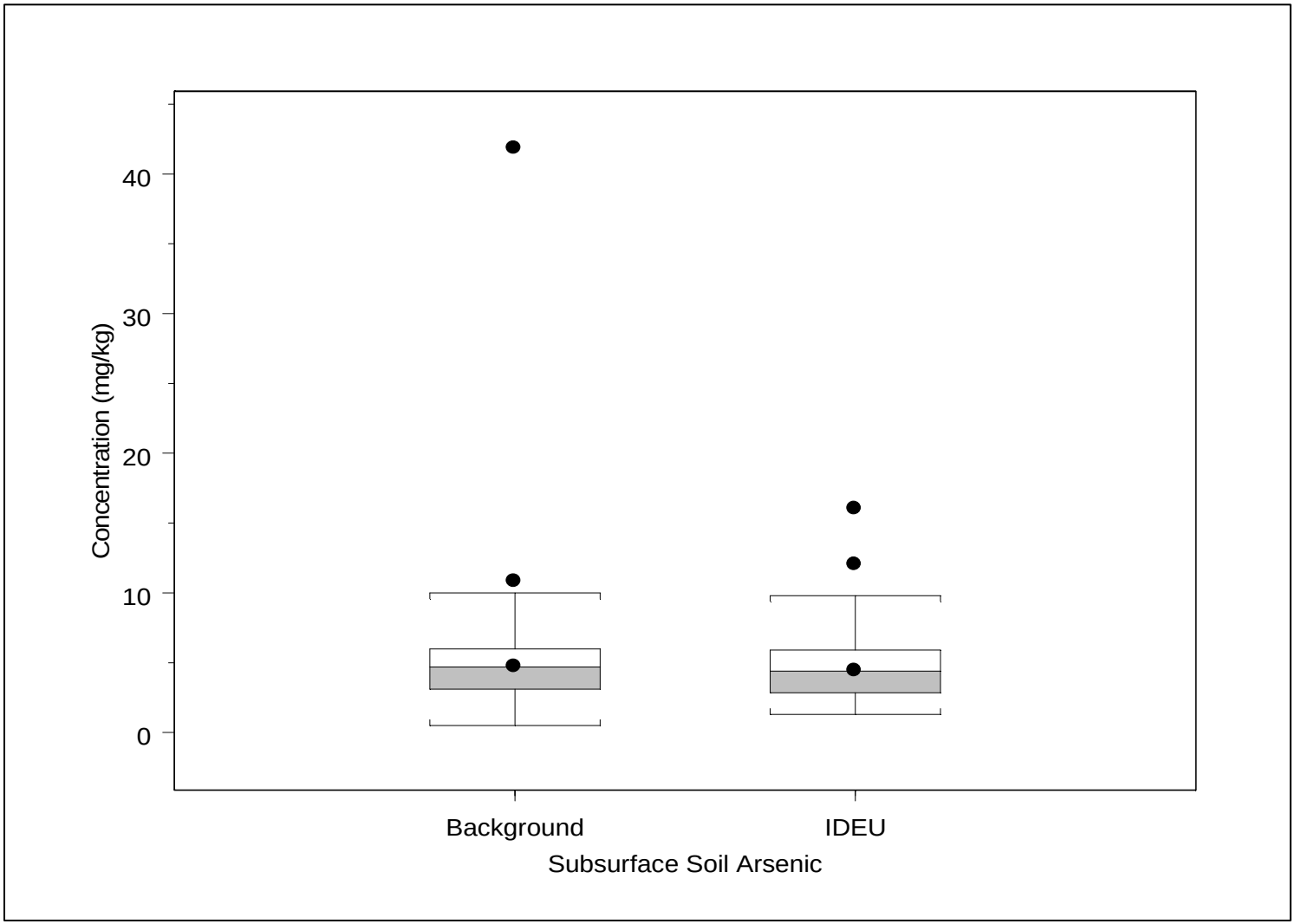
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.5
IDEU Surface Soil (PMJM) Box Plots for Arsenic



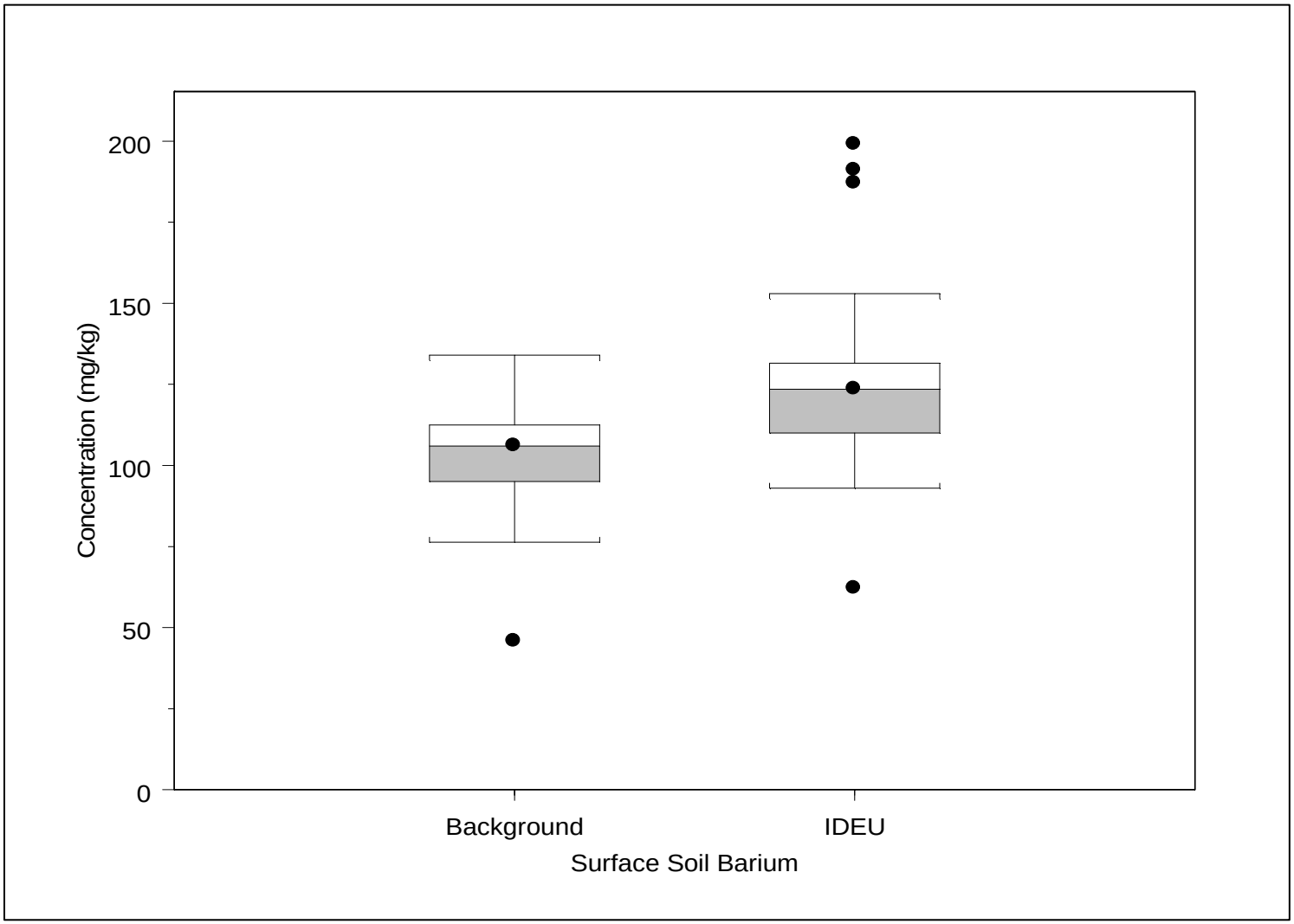
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.6
IDEU Subsurface Soil Box Plots for Arsenic



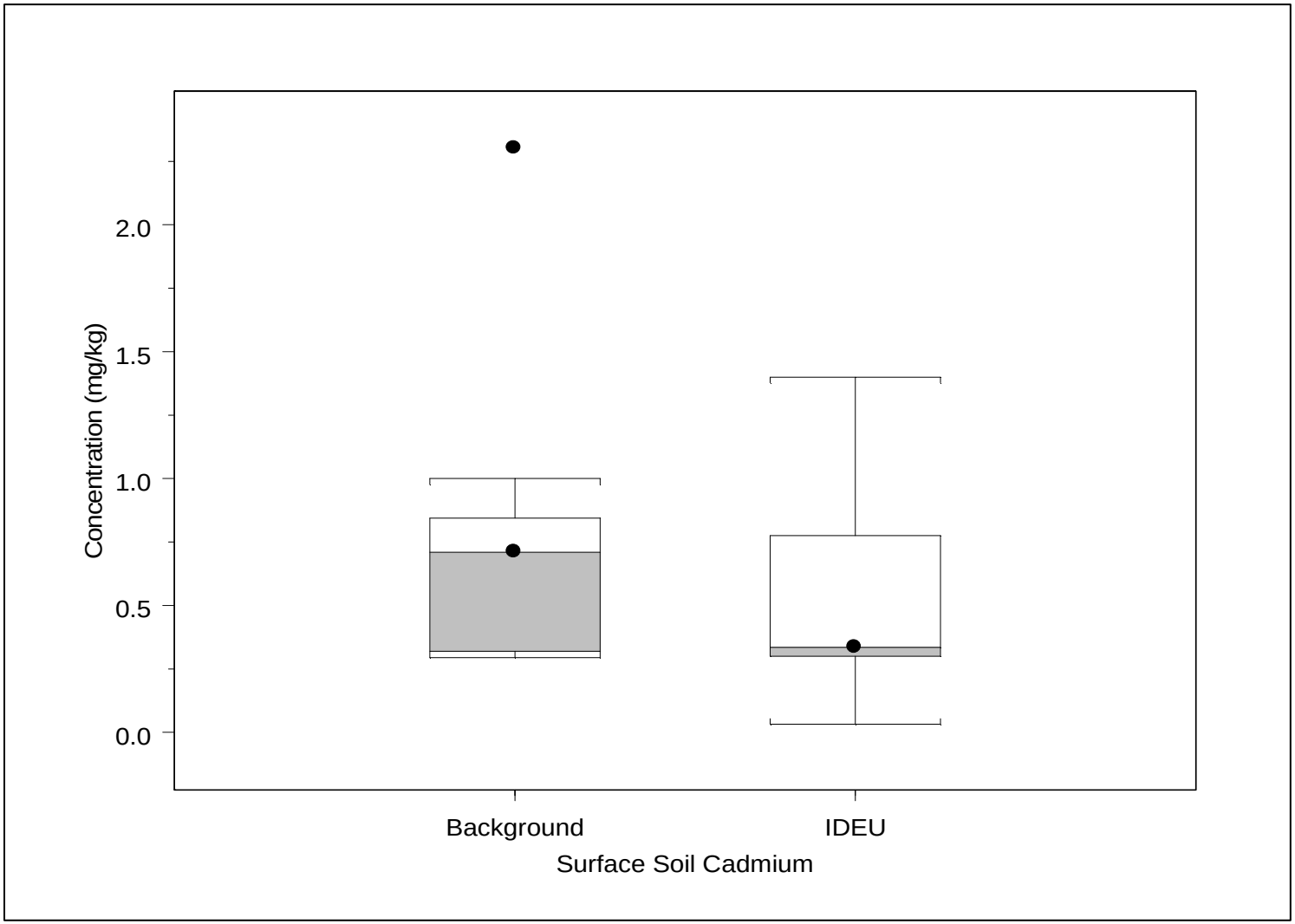
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.7
IDEU Surface Soil (Non-PMJM) Box Plots for Barium



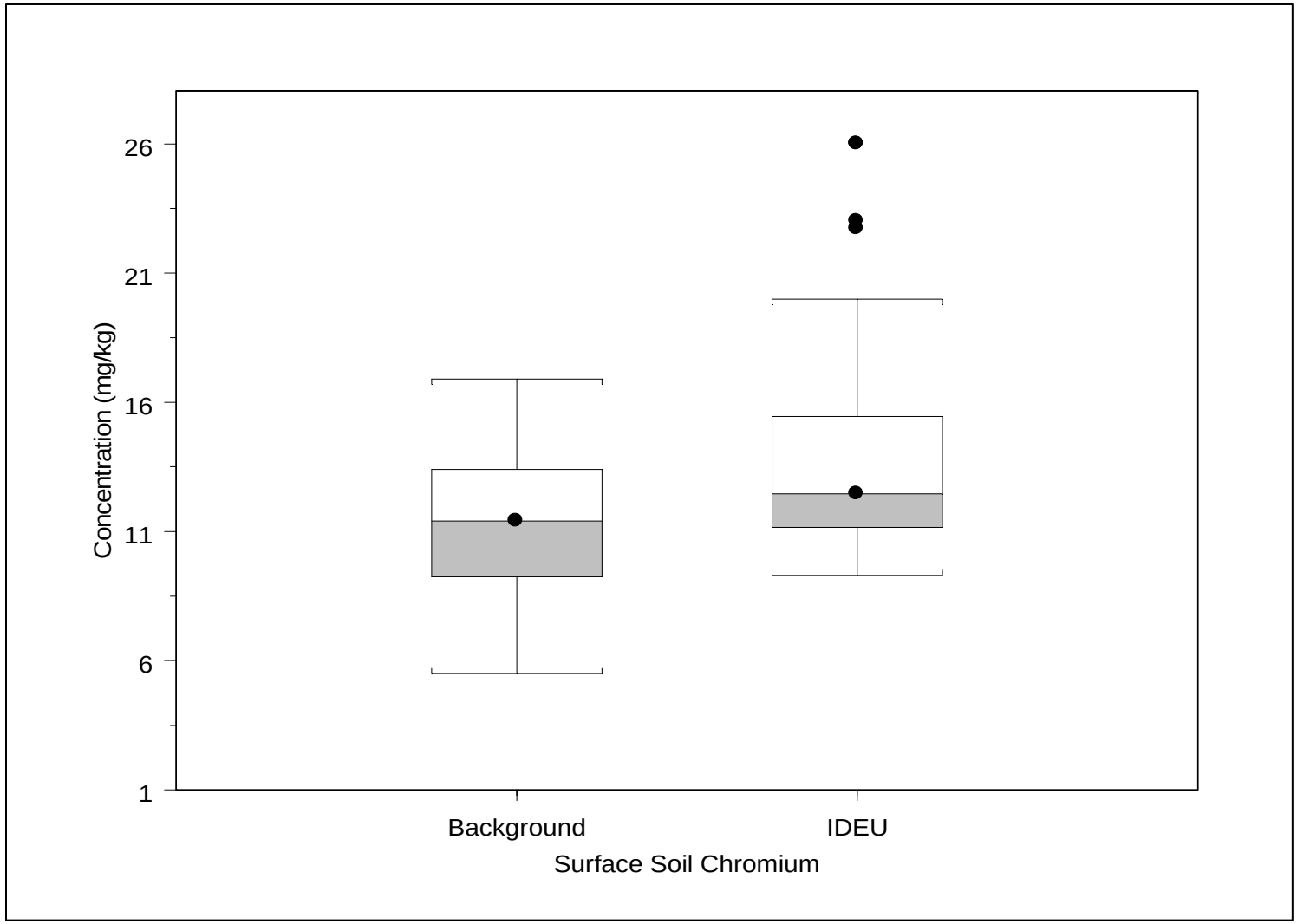
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.8
IDEU Surface Soil (Non-PMJM) Box Plots for Cadmium



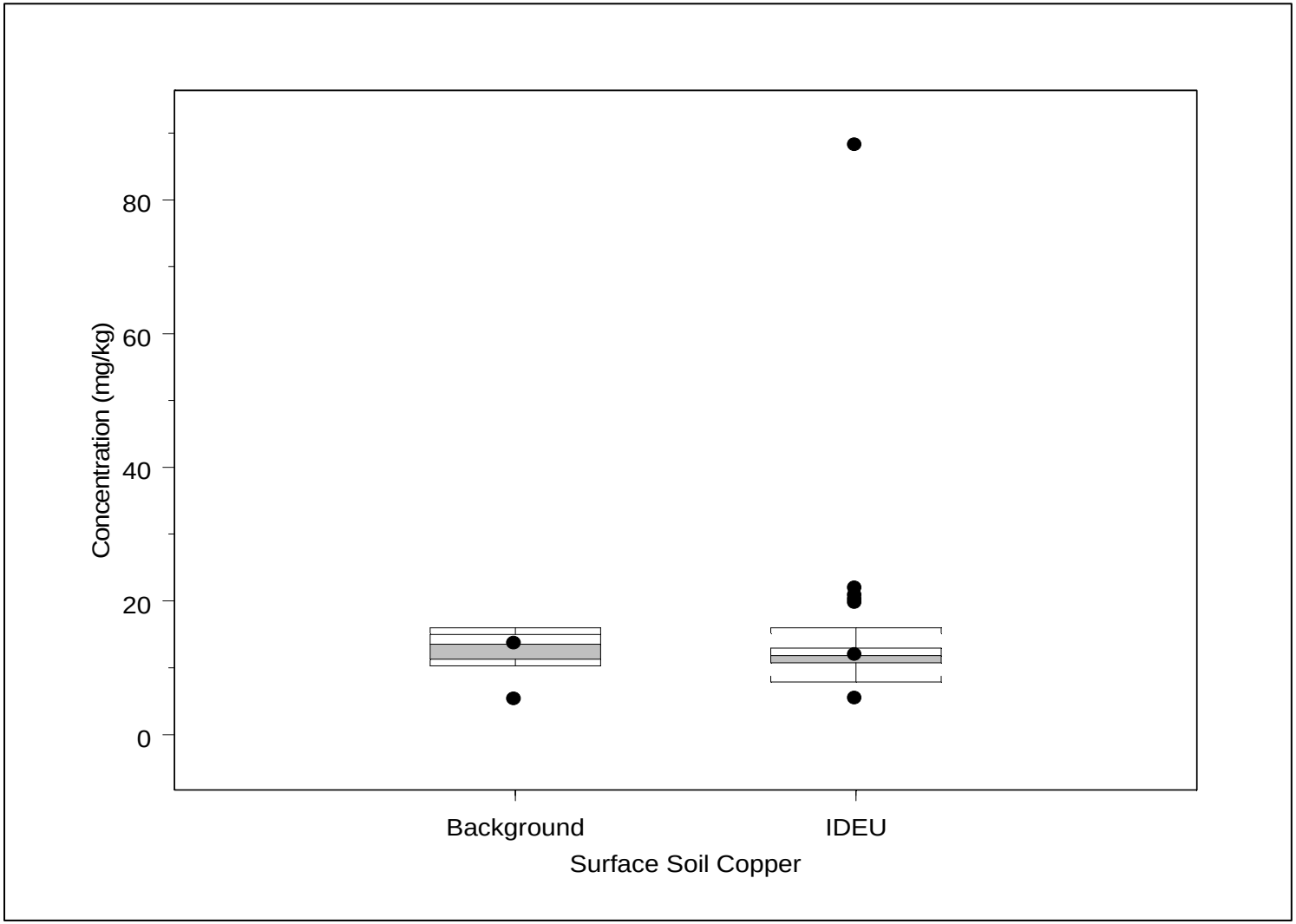
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.9
IDEU Surface Soil (Non-PMJM) Box Plots for Chromium



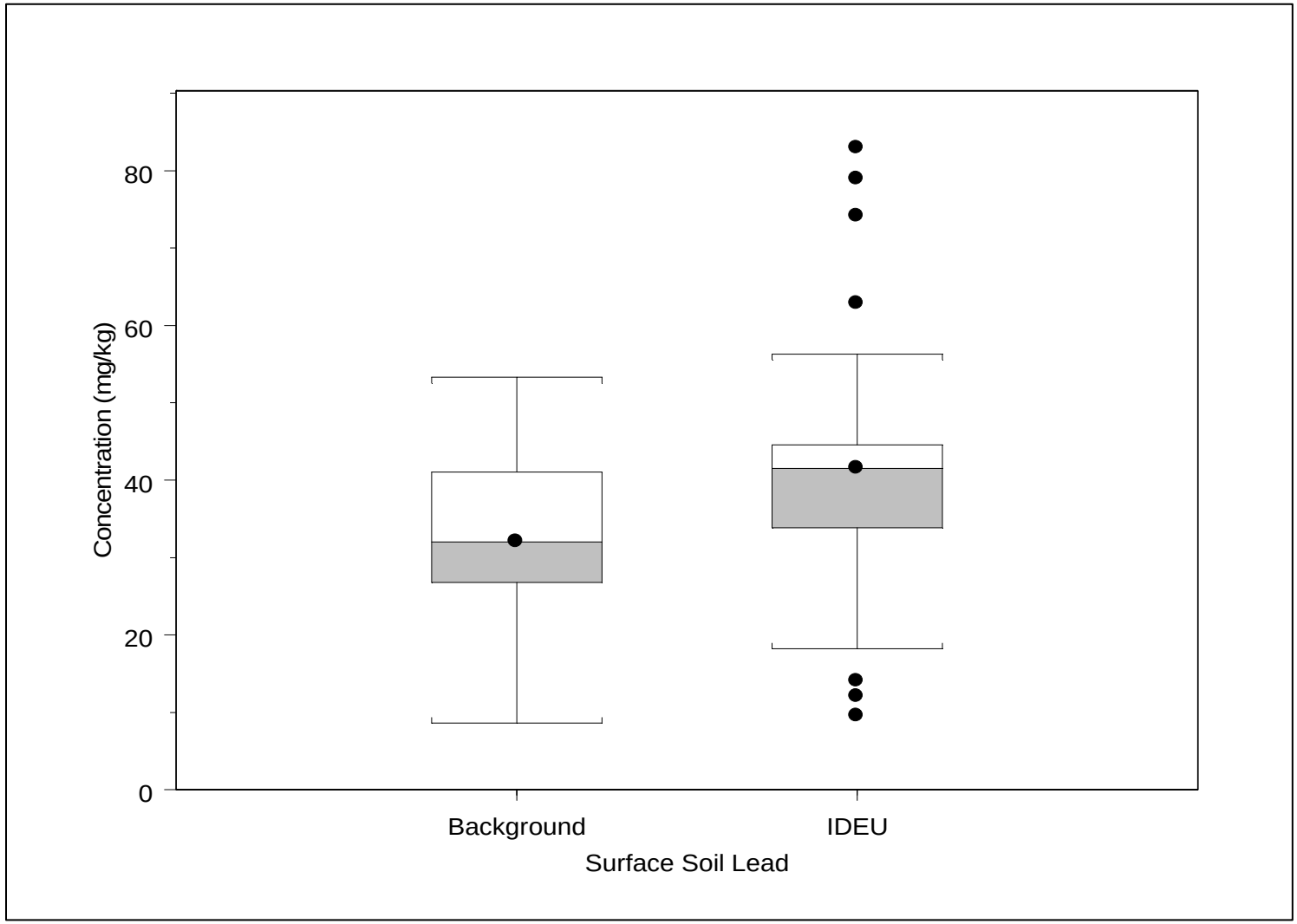
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.10
IDEU Surface Soil (Non-PMJM) Box Plots for Copper



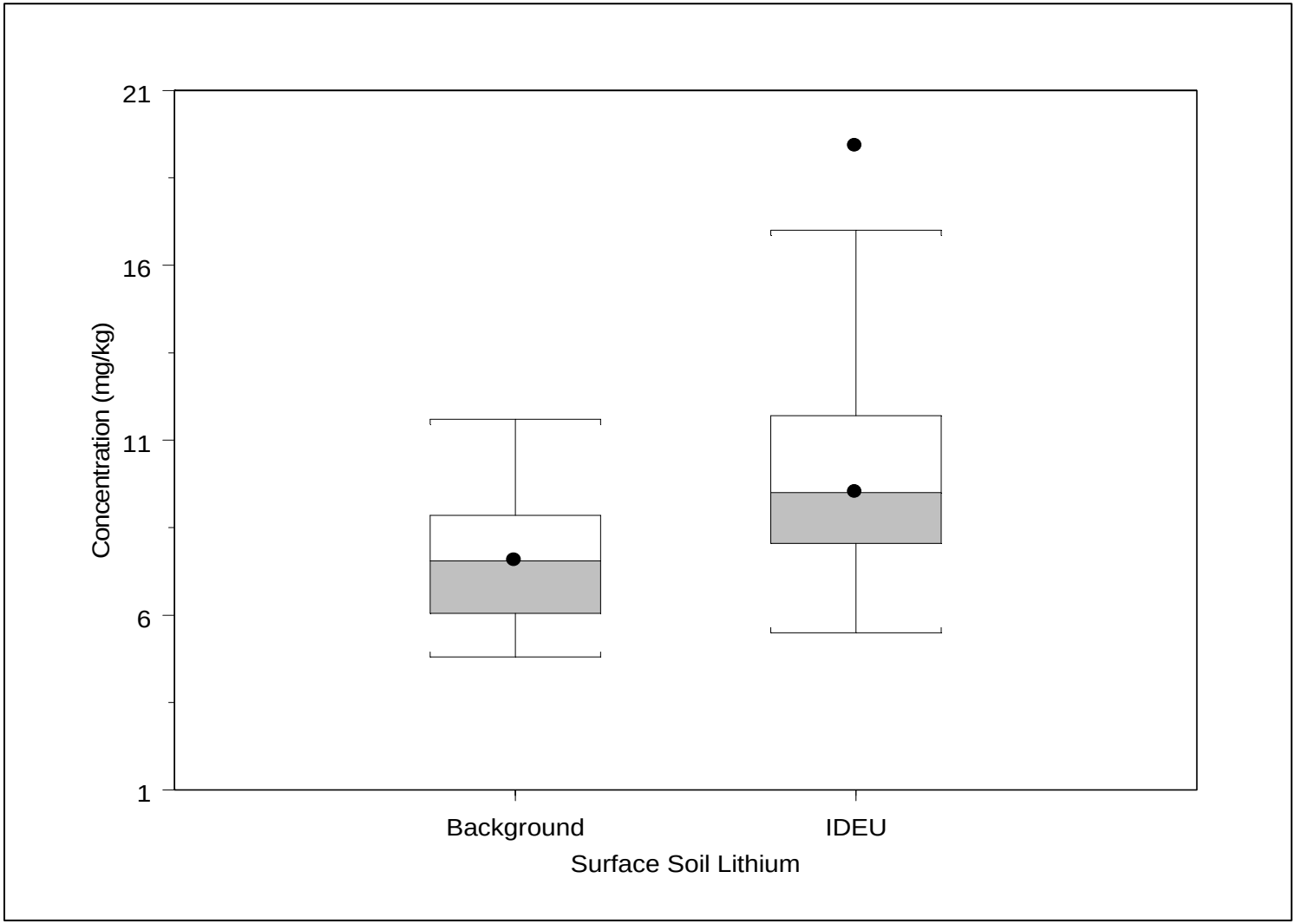
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.11
IDEU Surface Soil (Non-PMJM) Box Plots for Lead



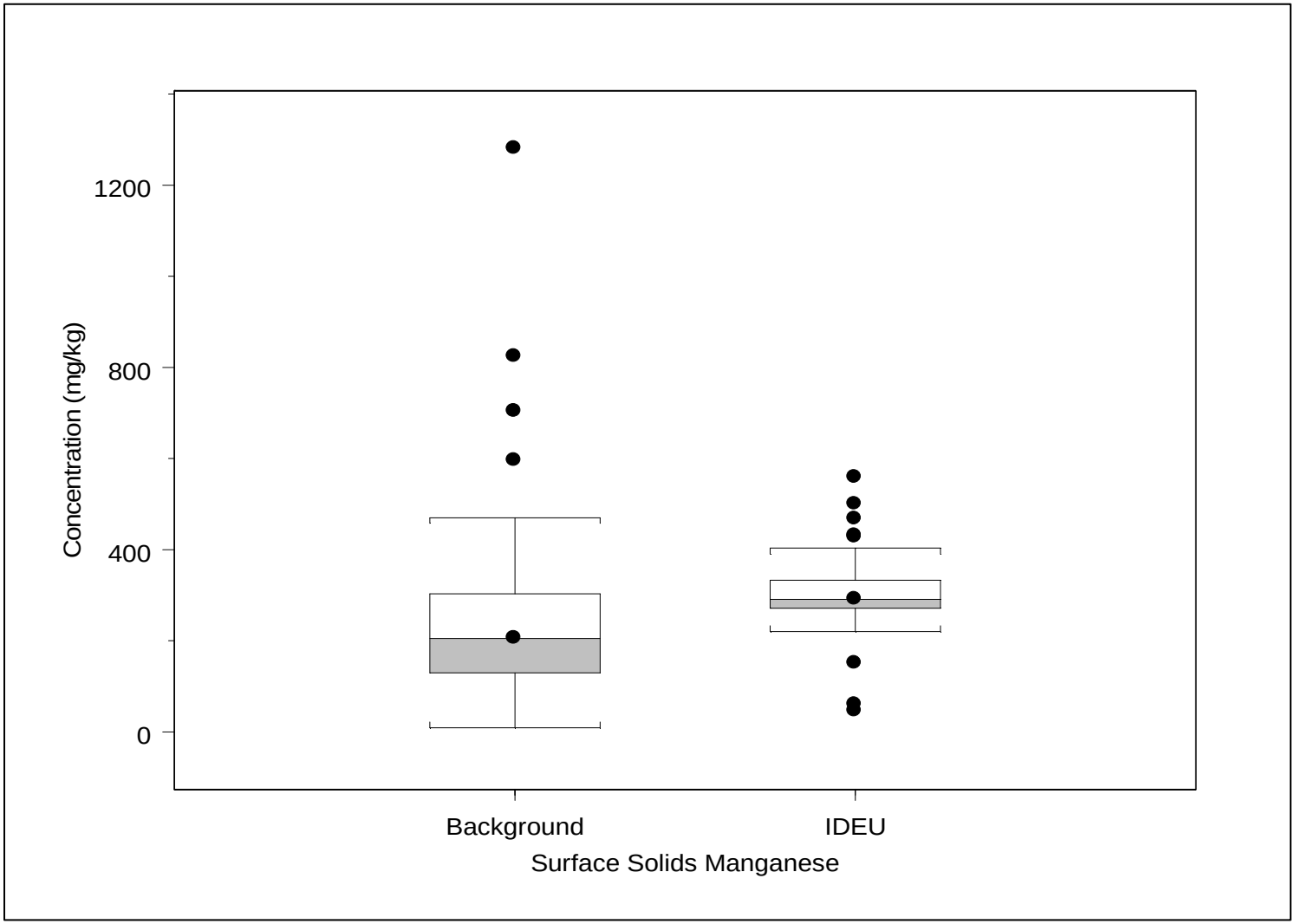
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.12
IDEU Surface Soil (Non-PMJM) Box Plots for Lithium



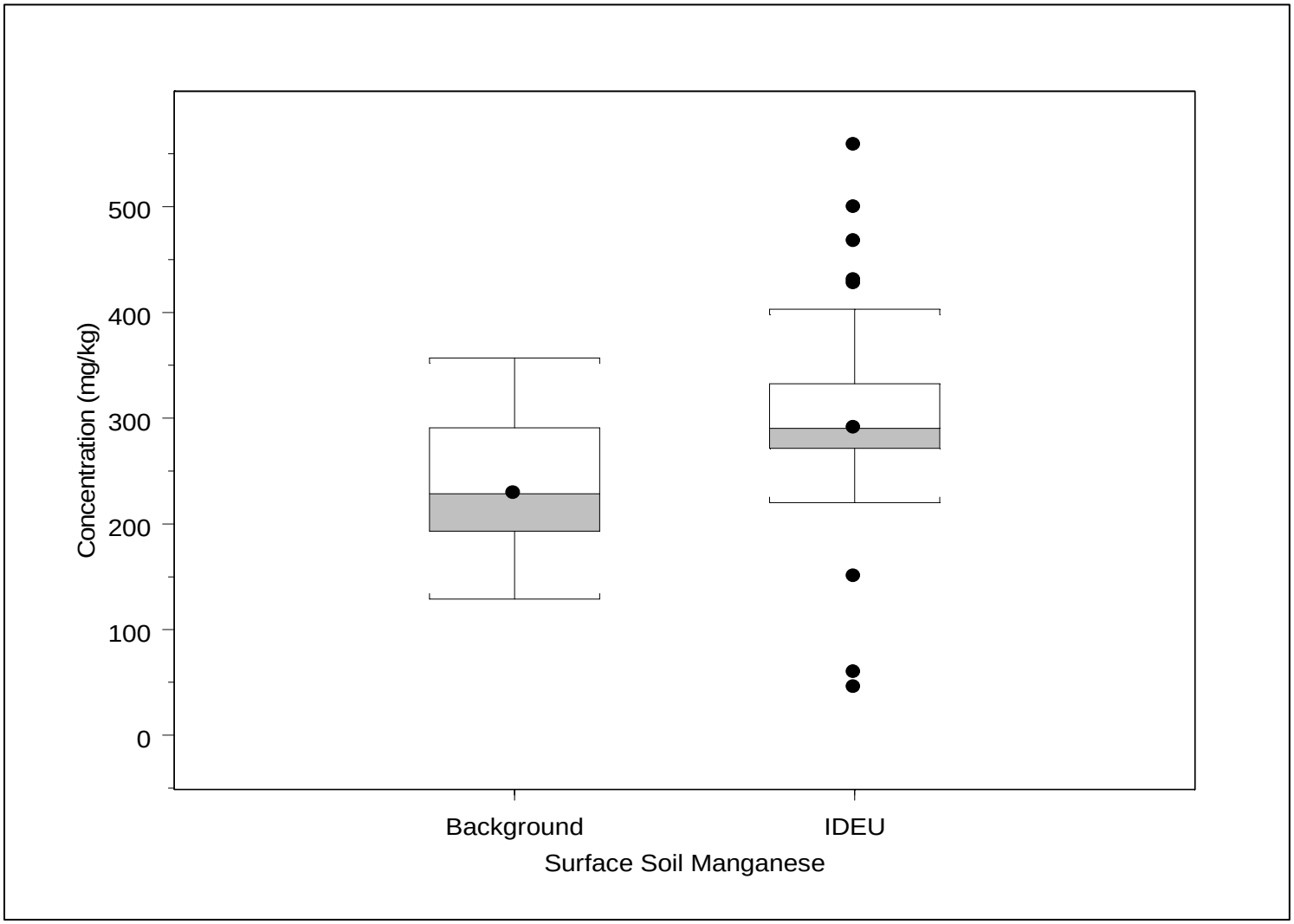
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.13
IDEU Surface Soil/Surface Sediment Box Plots for Manganese



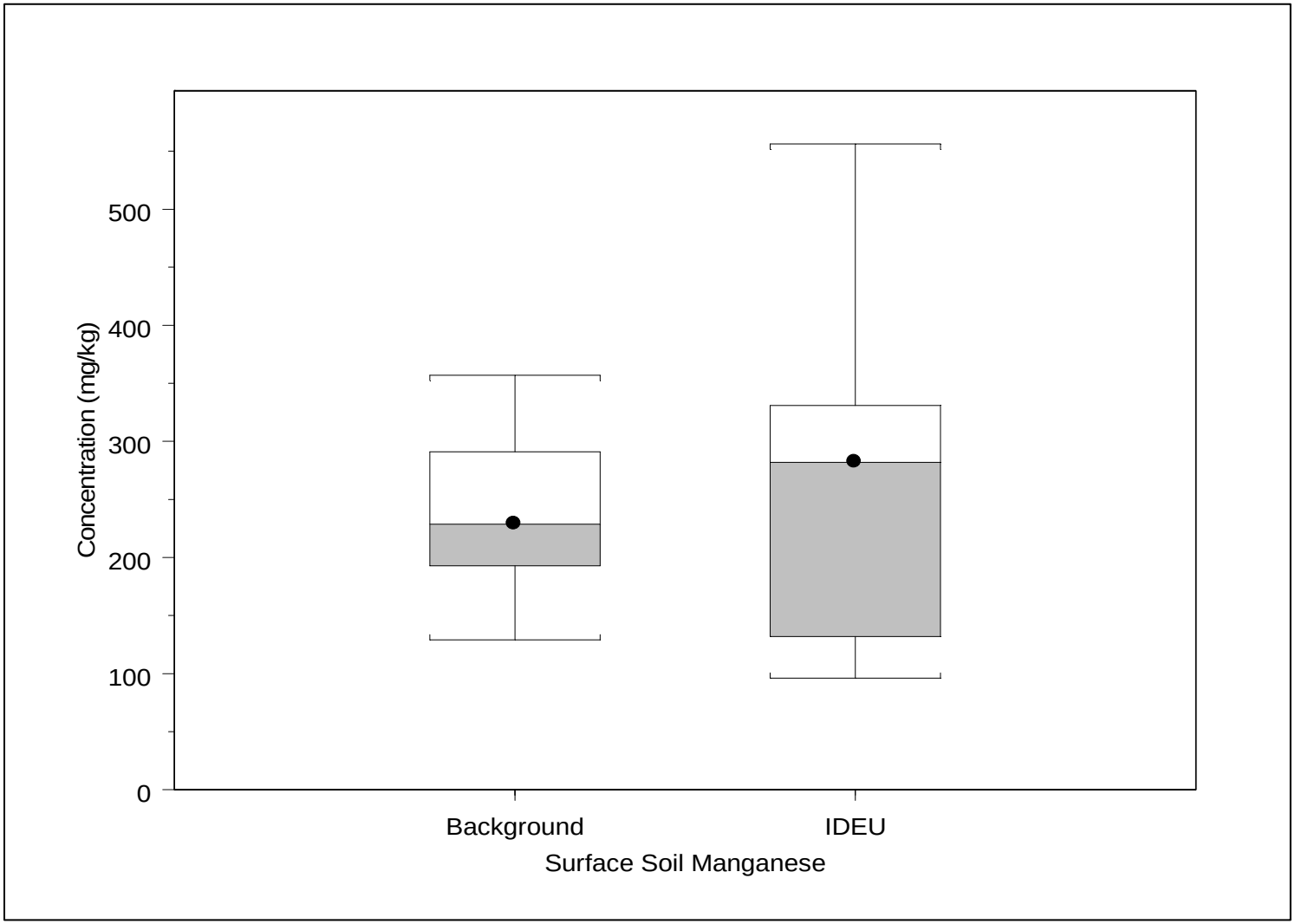
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.14
IDEU Surface Soil (Non-PMJM) Box Plots for Manganese



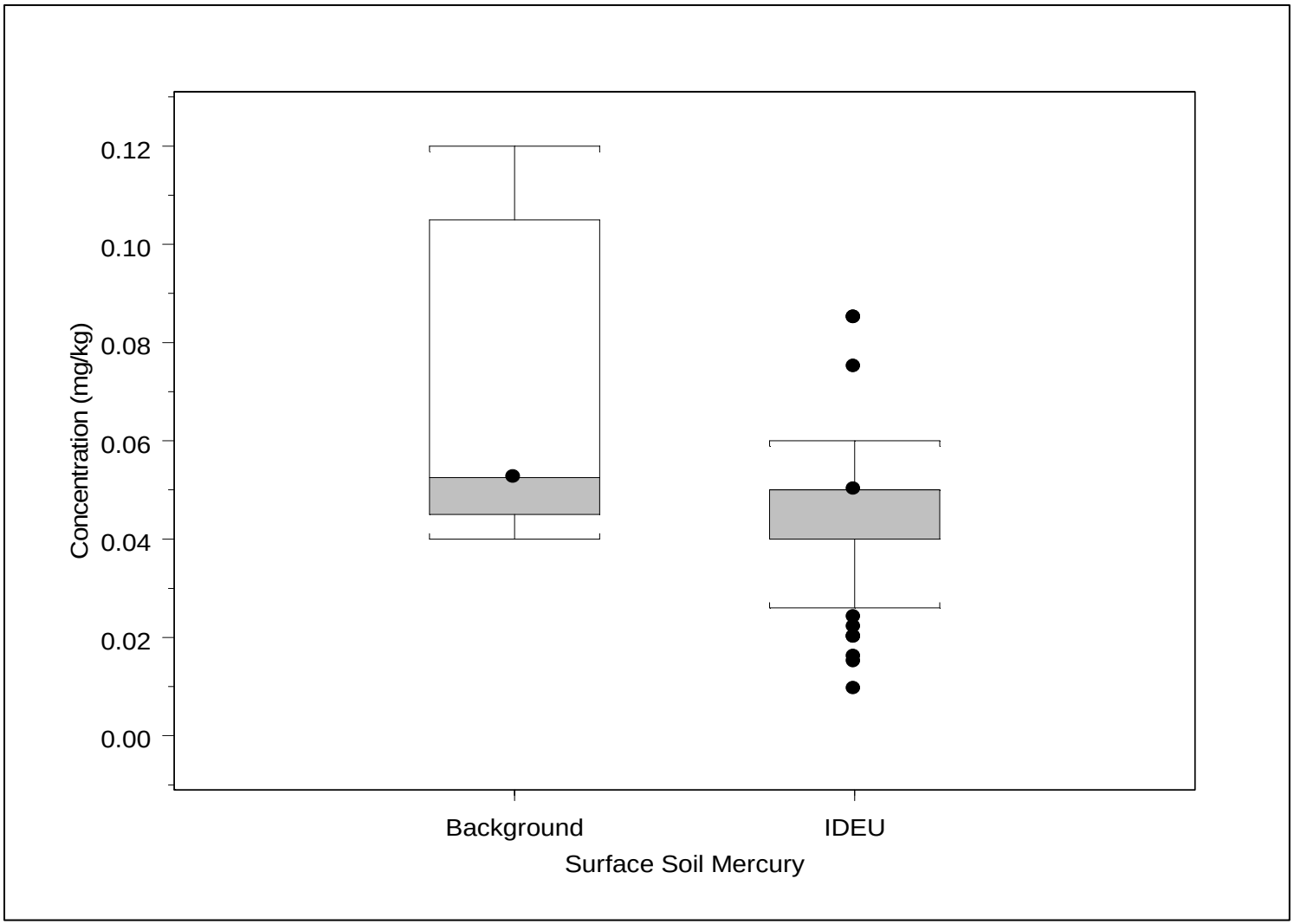
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.15
IDEU Surface Soil (PMJM) Box Plots for Manganese



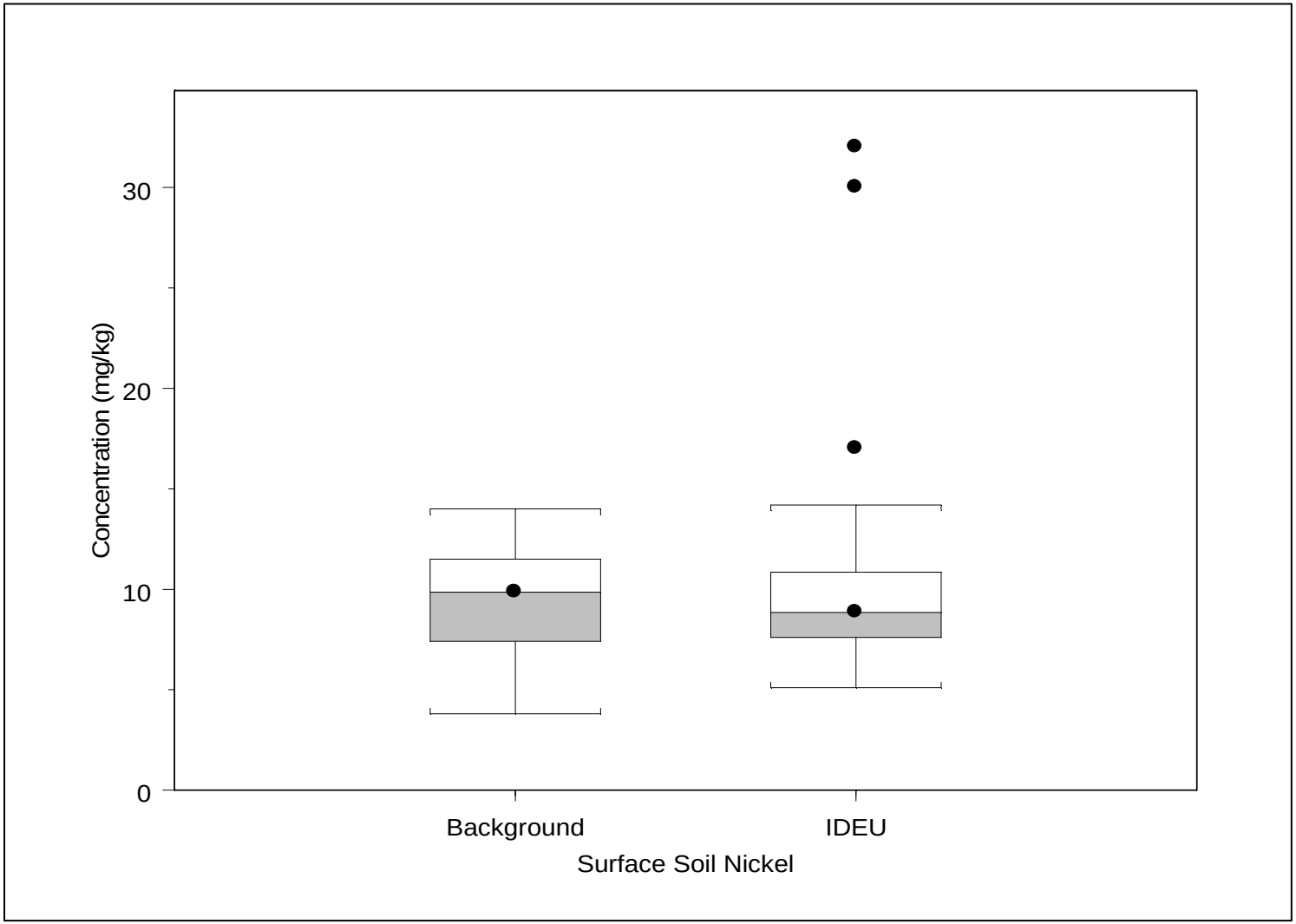
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.16
IDEU Surface Soil (Non-PMJM) Box Plots for Mercury



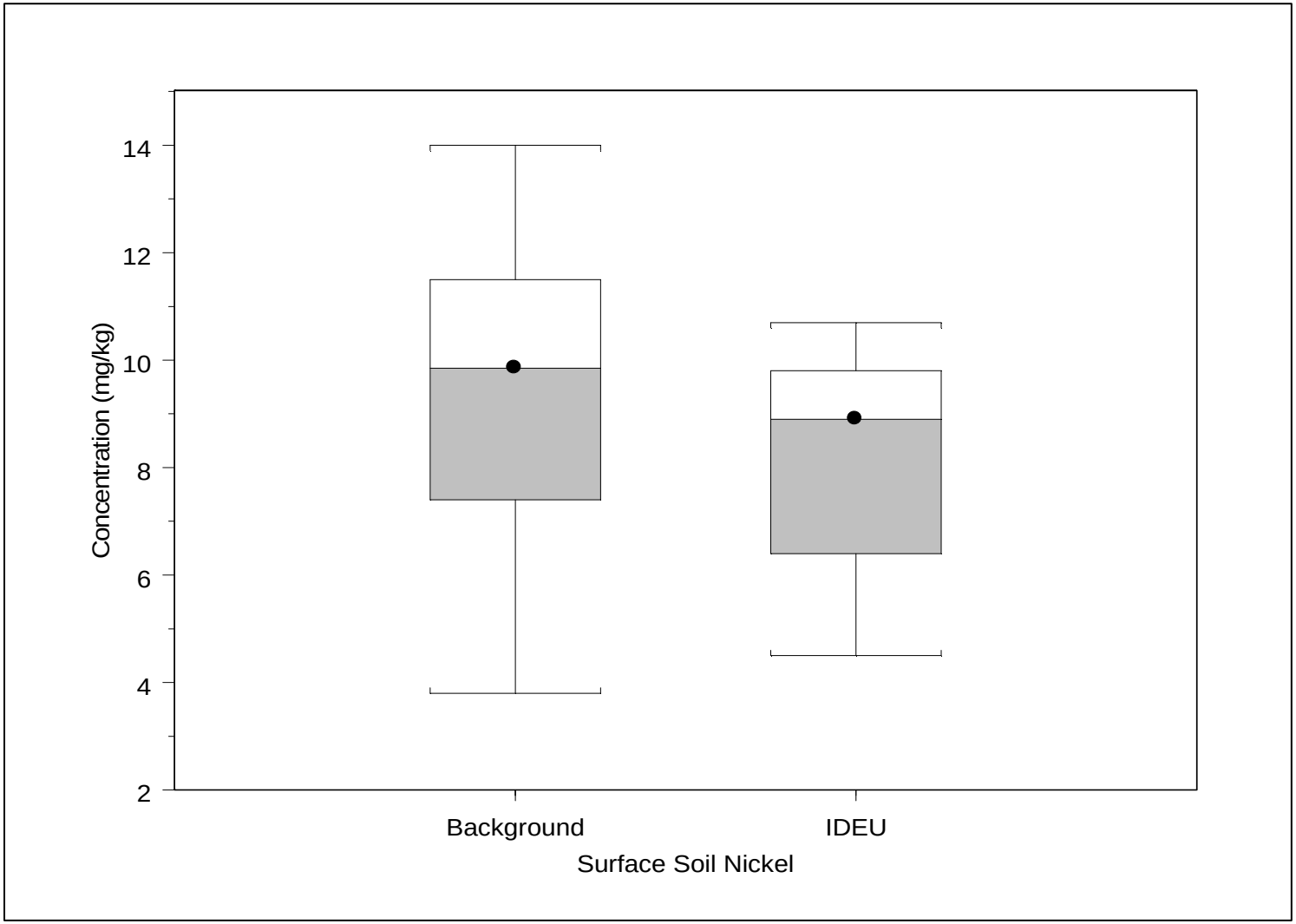
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.17
IDEU Surface Soil (Non-PMJM) Box Plots for Nickel



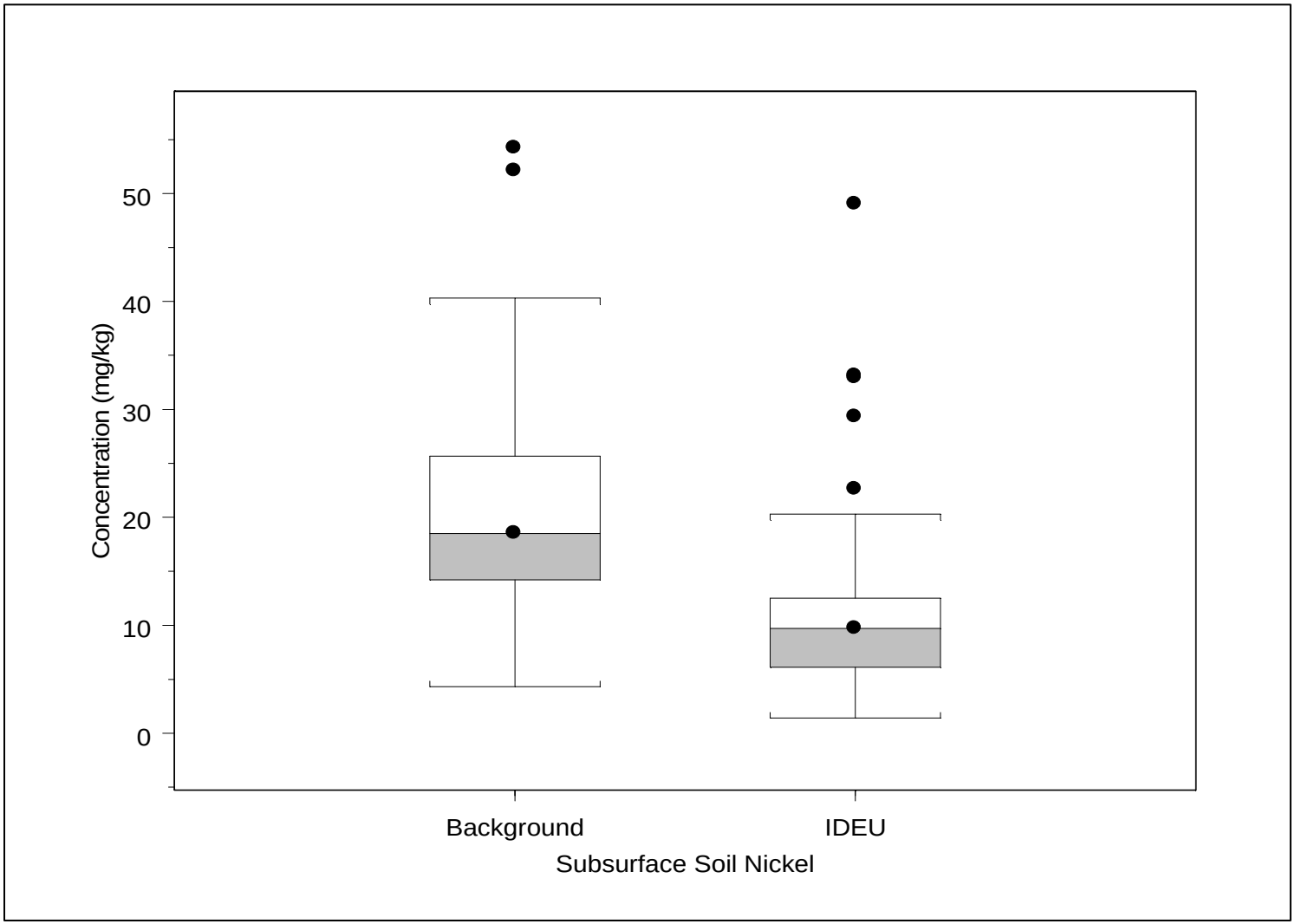
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.18
IDEU Surface Soil (PMJM) Box Plots for Nickel



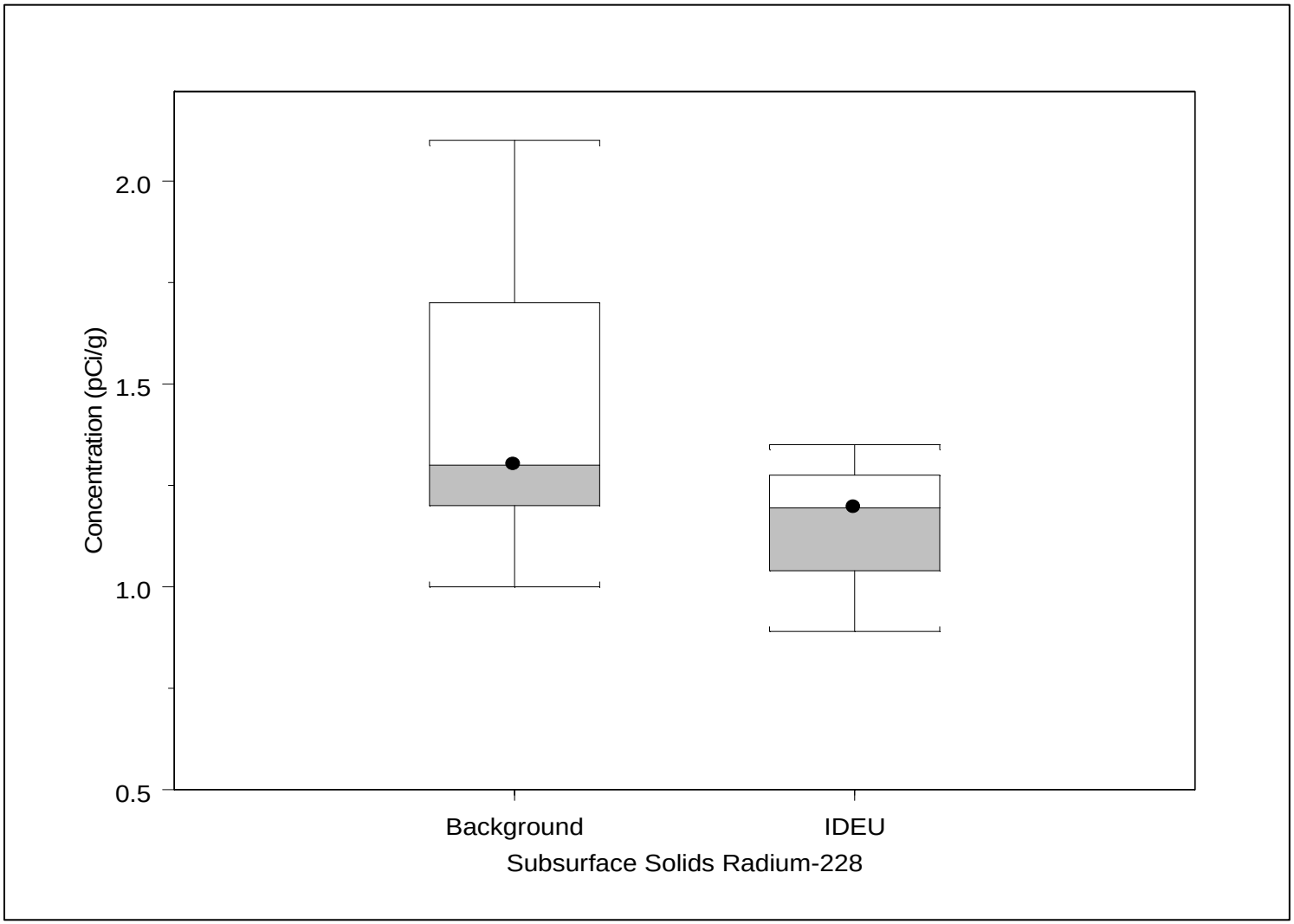
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.19
IDEU Subsurface Soil Box Plots for Nickel



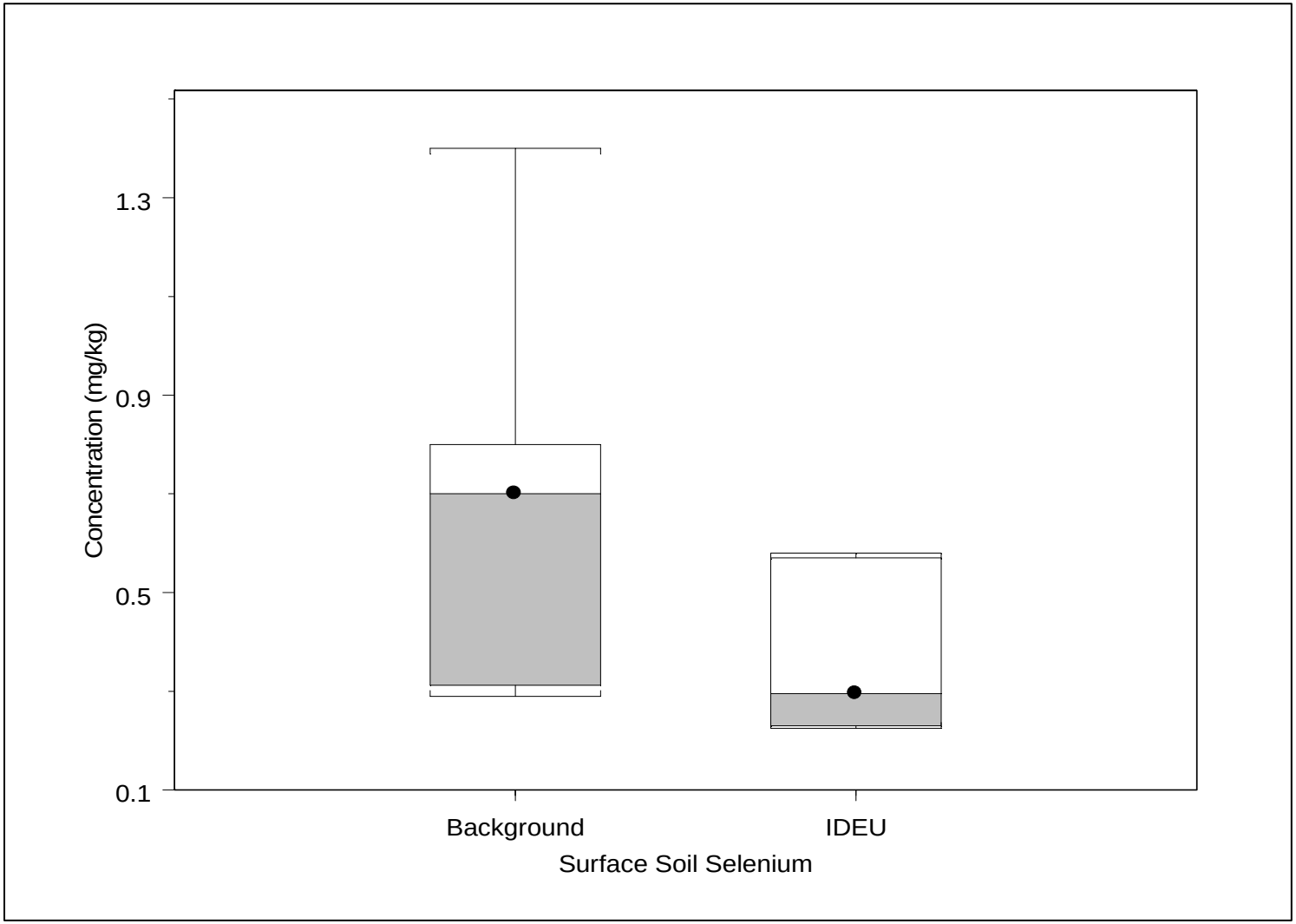
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.20
IDEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



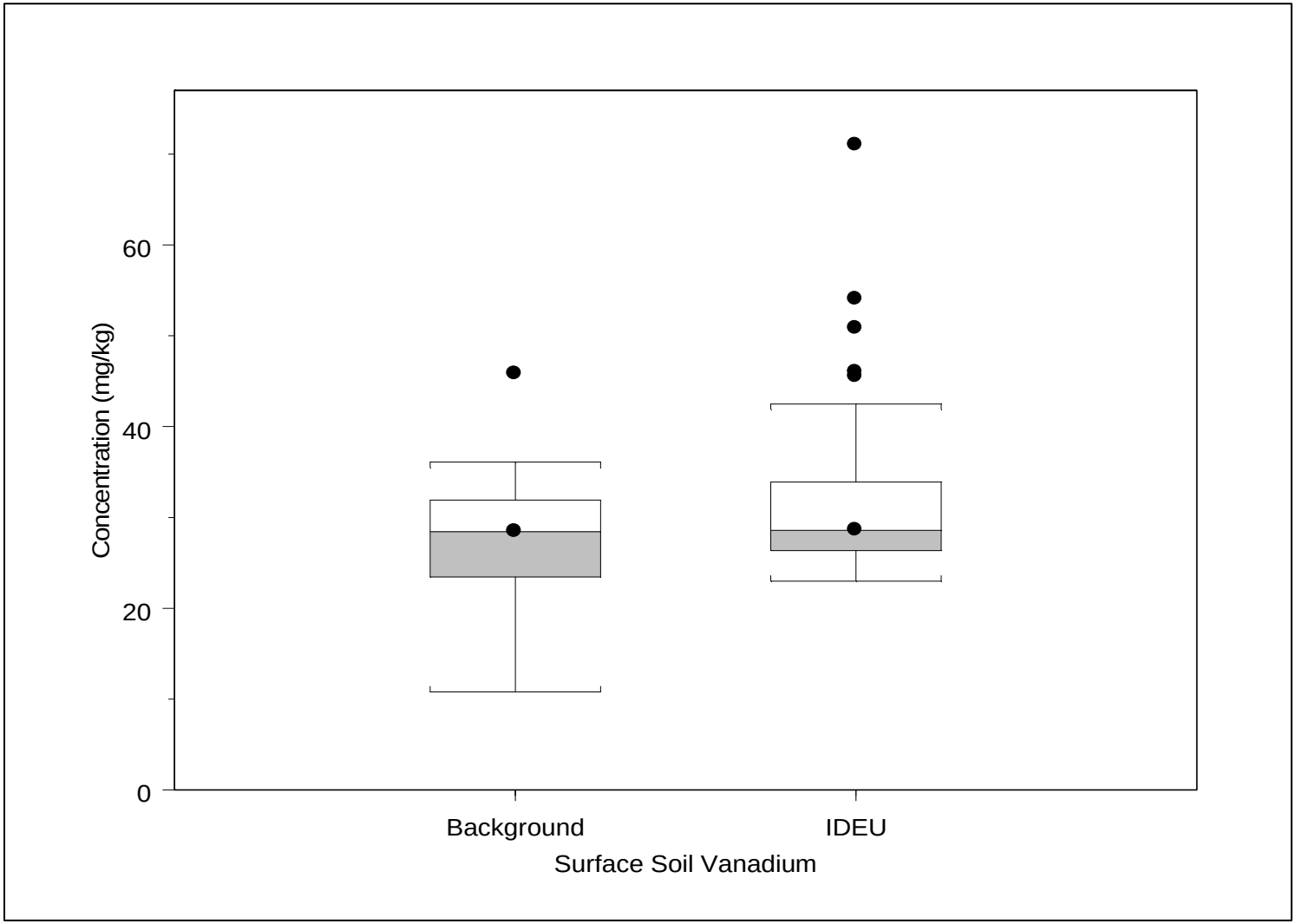
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.21
IDEU Surface Soil (PMJM) Box Plots for Selenium



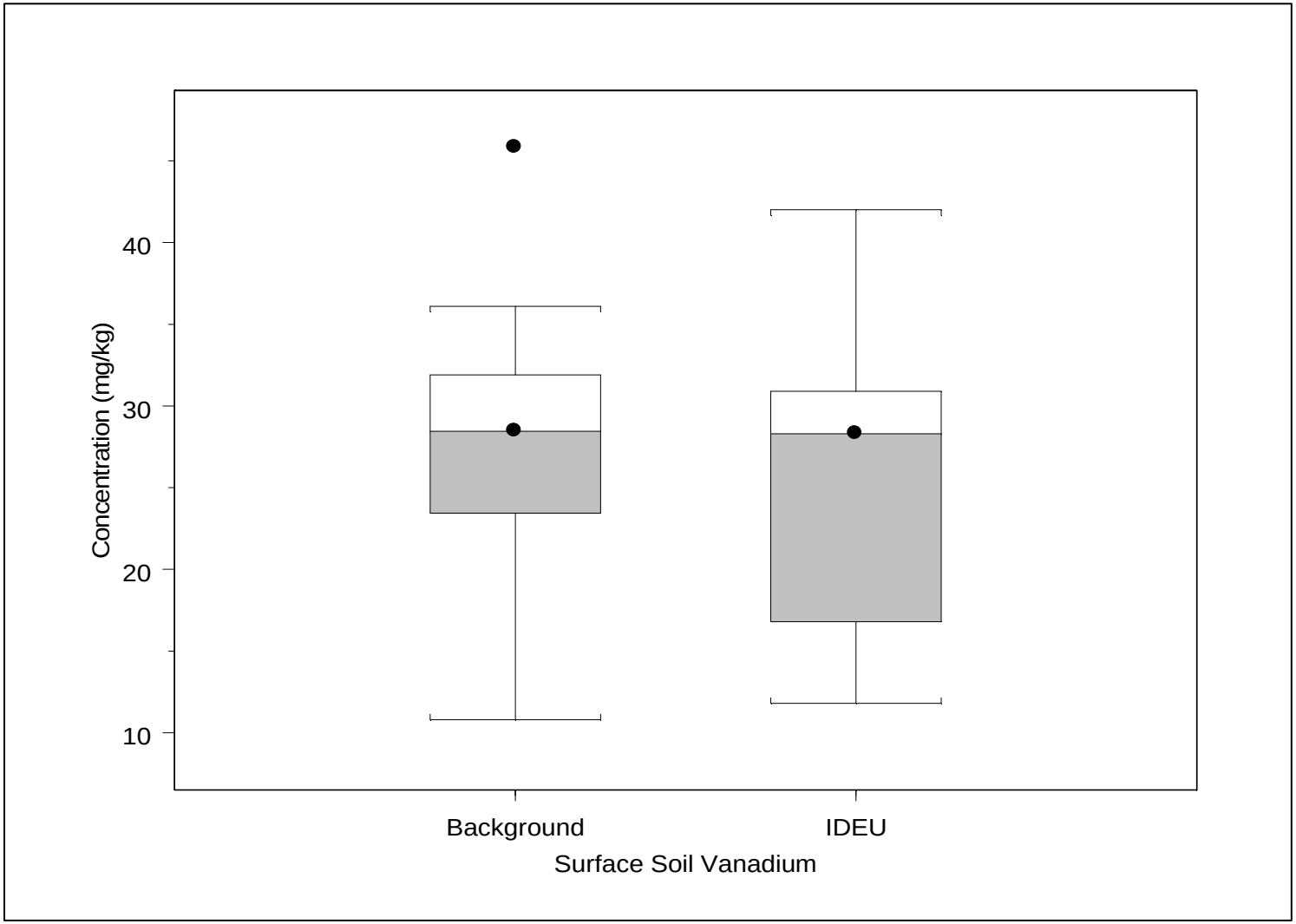
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.22
IDEU Surface Soil (Non-PMJM) Box Plots for Vanadium



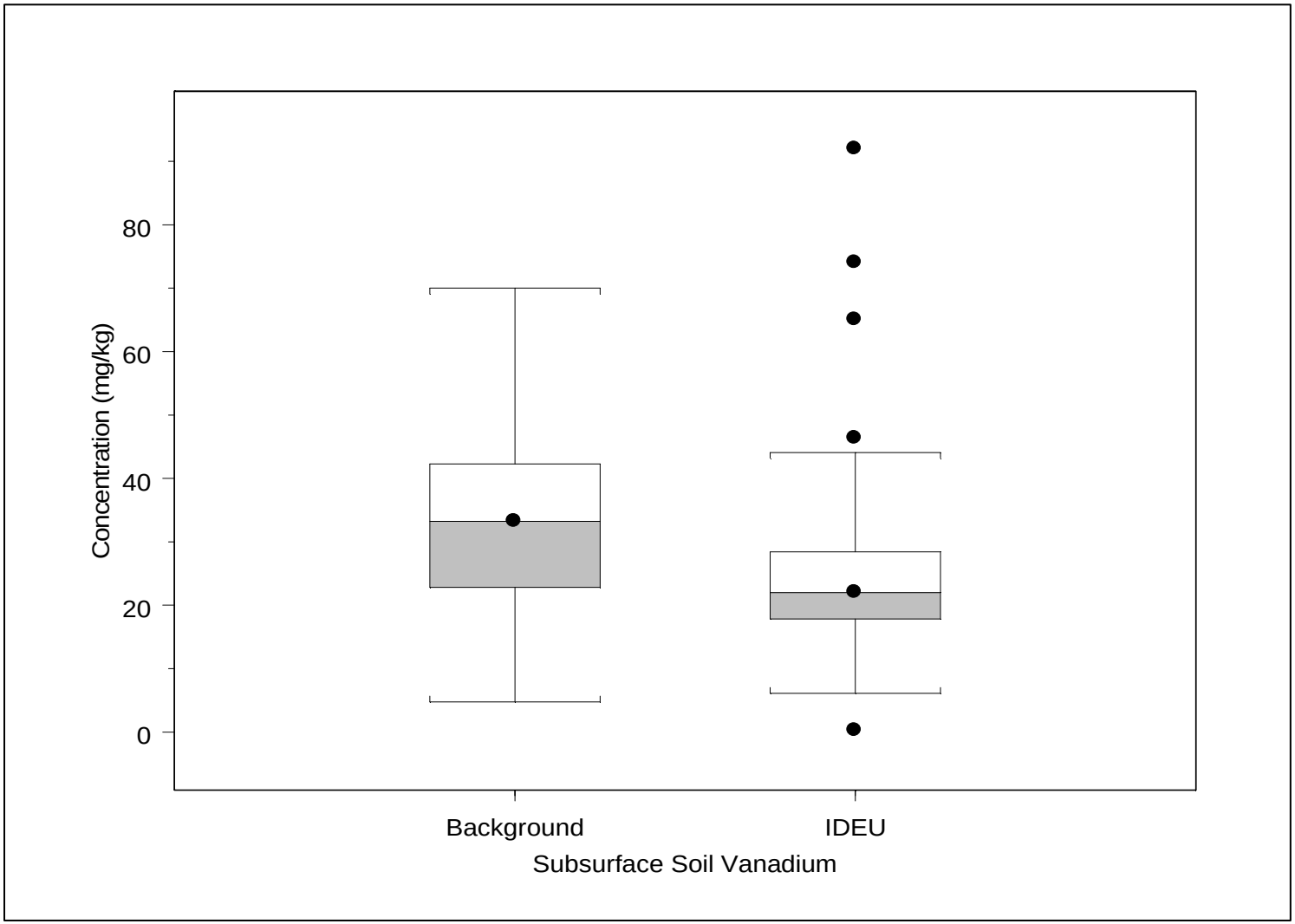
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.23
IDEU Surface Soil (PMJM) Box Plots for Vanadium



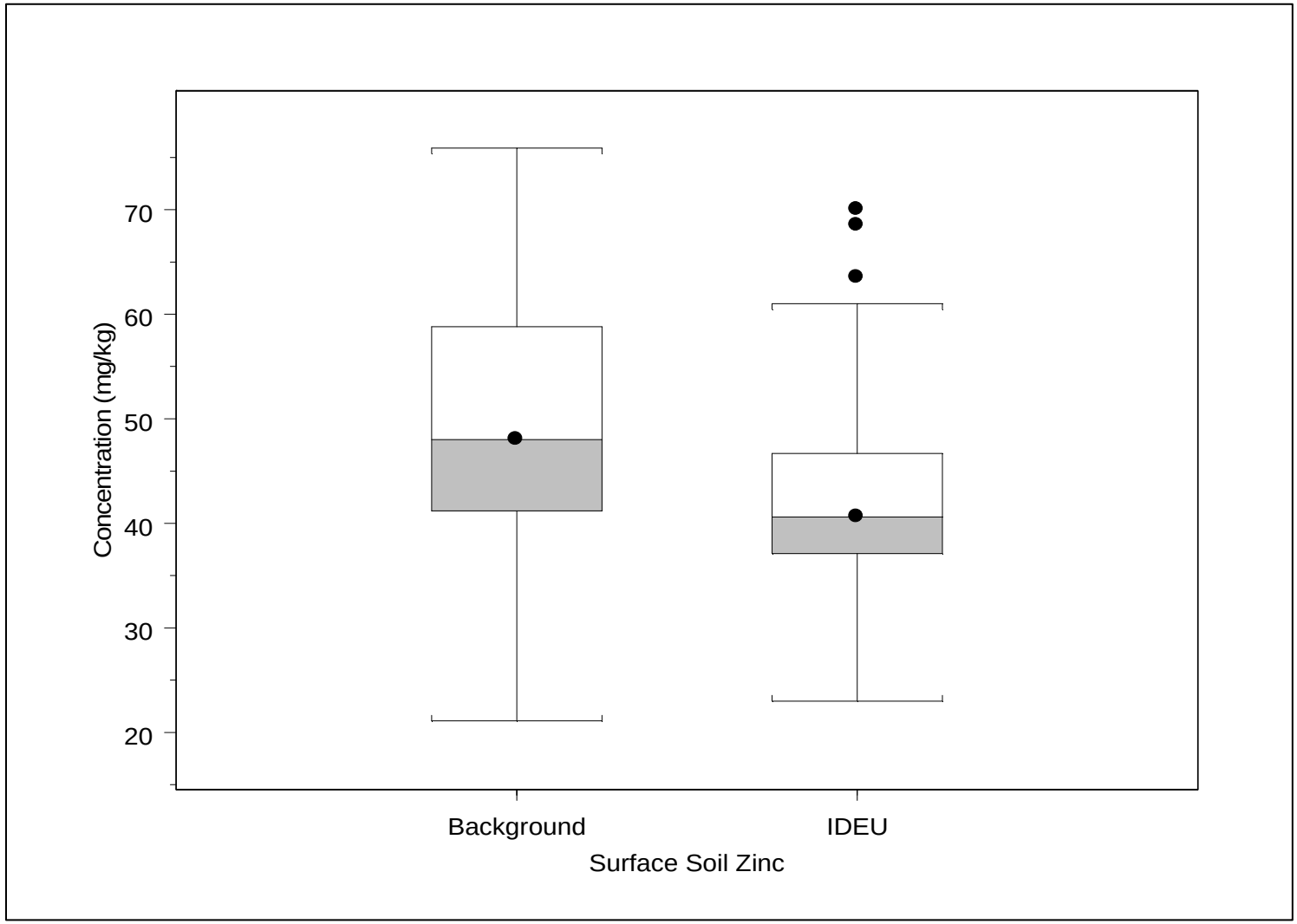
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.24
IDEU Subsurface Soil Box Plots for Vanadium



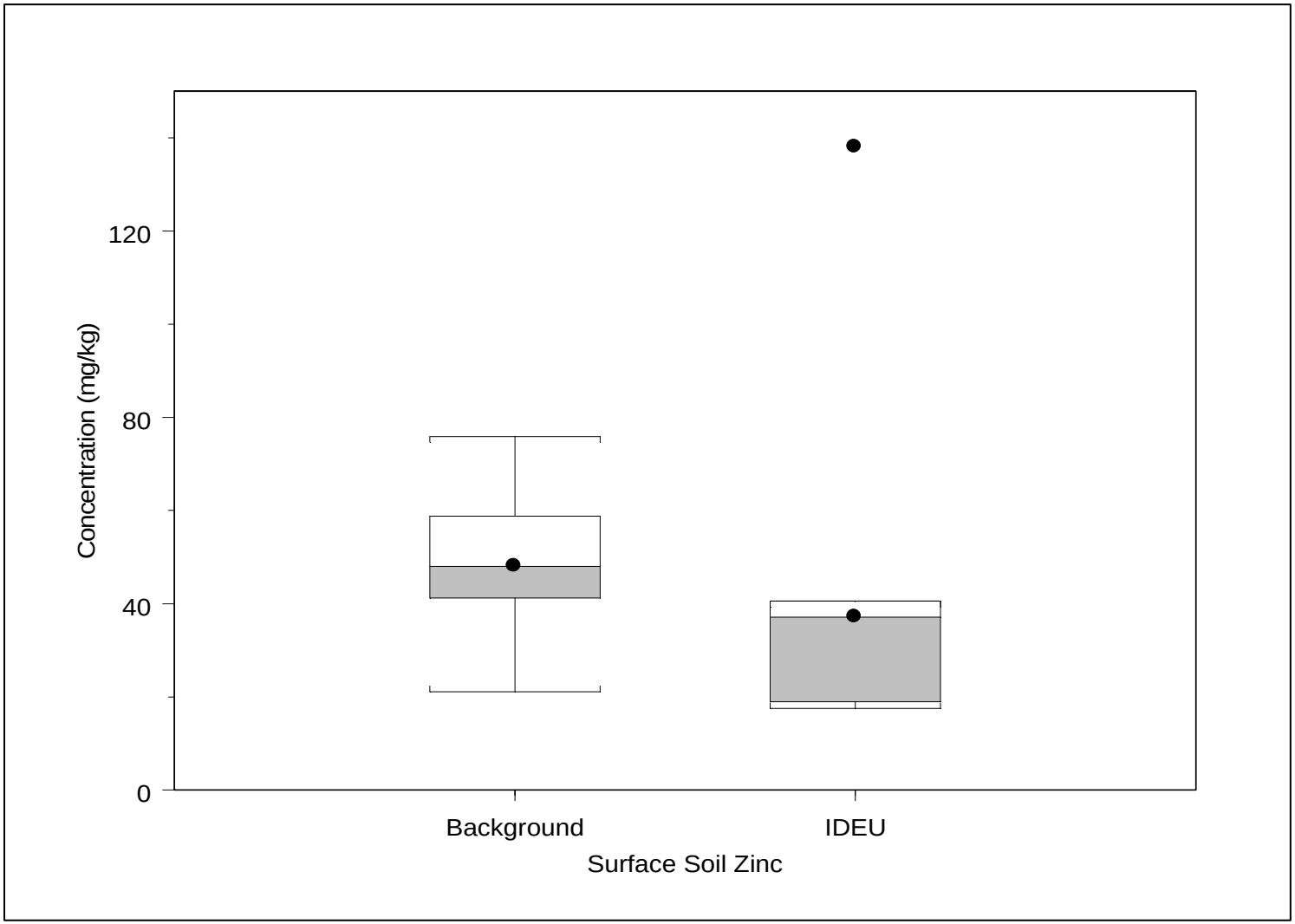
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.25
IDEU Surface Soil (Non-PMJM) Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.26
IDEU Surface Soil (PMJM) Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

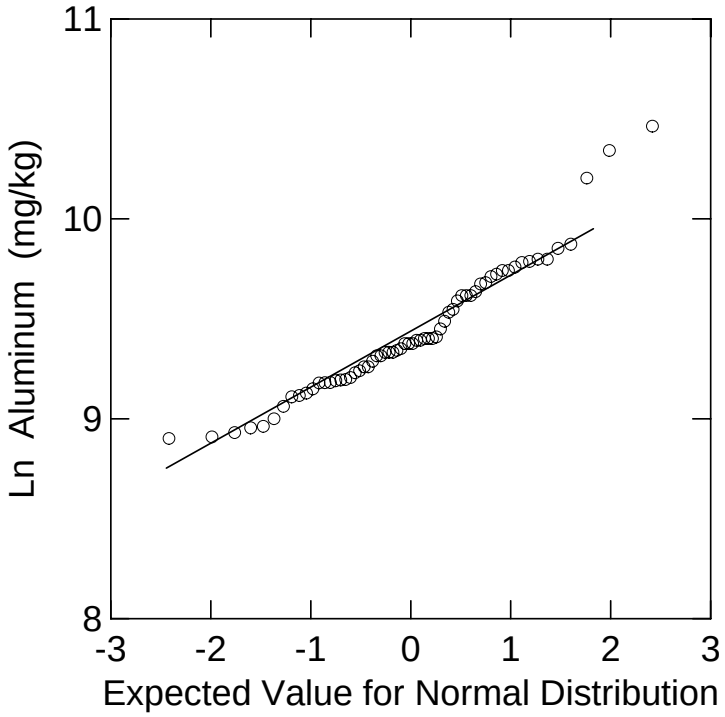


Figure A3.4.1 Probability Plot for Aluminum Concentrations (Natural Logarithm) in IDEU Surface Soil

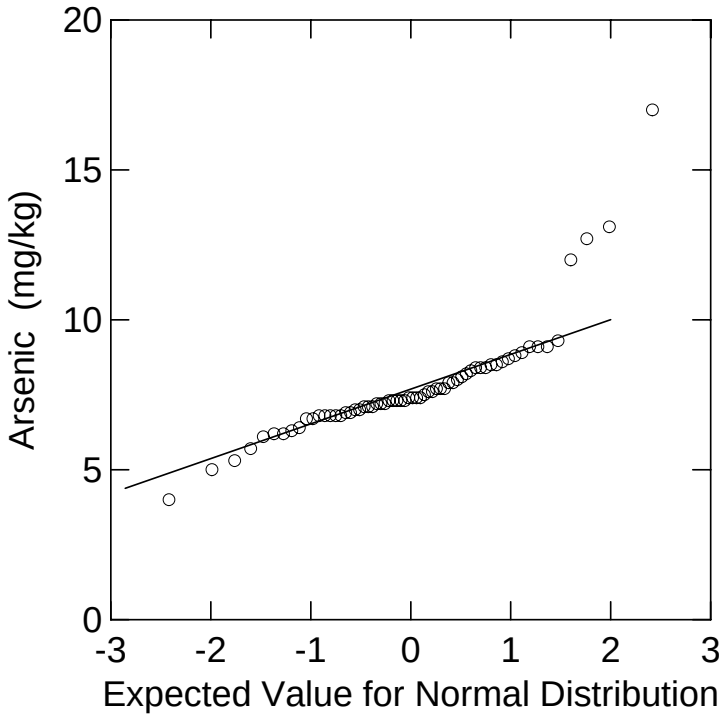


Figure A3.4.2 Probability Plot for Arsenic Concentrations in IDEU Surface Soil/Surface Sediment

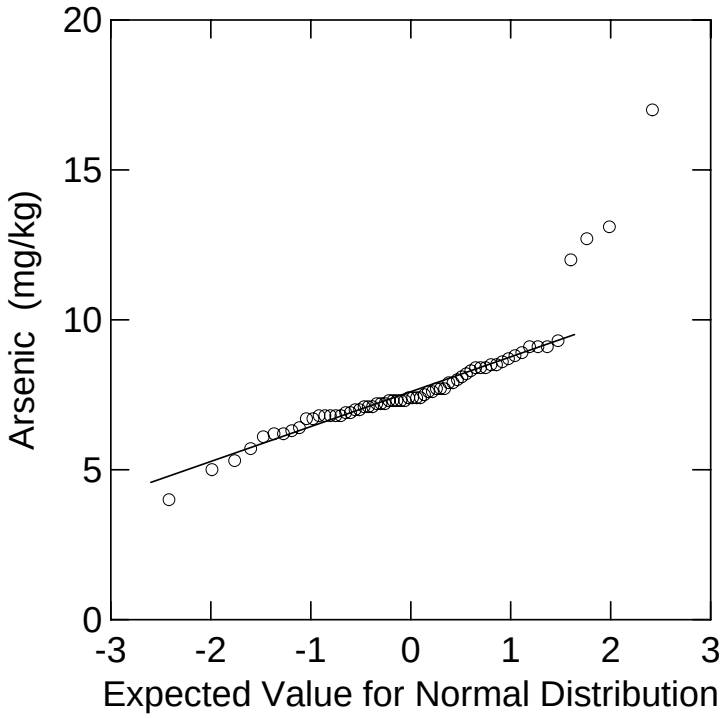


Figure A3.4.3 Probability Plot for Arsenic Concentrations in IDEU Surface Soil

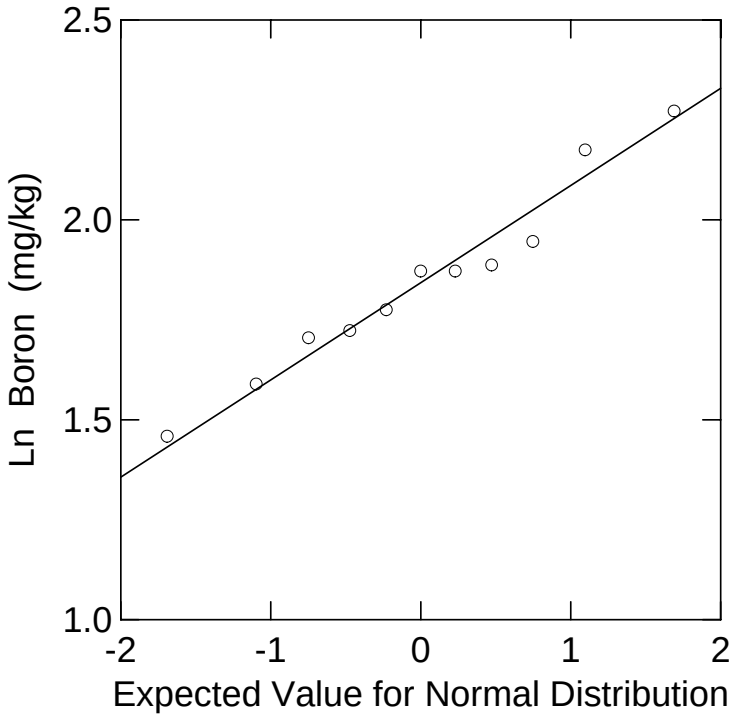


Figure A3.4.4 **Probability Plot for Boron Concentrations (Natural Logarithm) in IDEU Surface Soil**

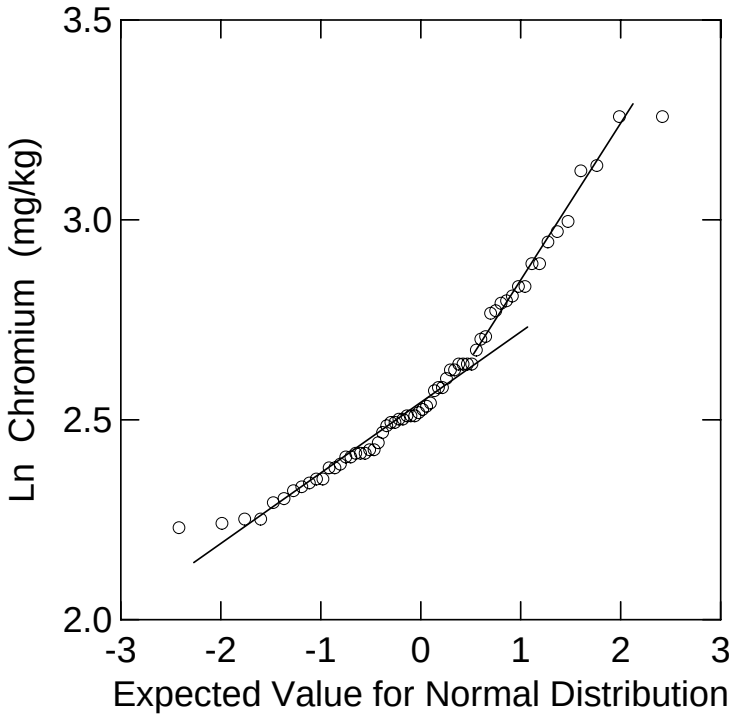


Figure A3.4.5 Probability Plot for Chromium Concentrations (Natural Logarithm) in IDEU Surface Soil

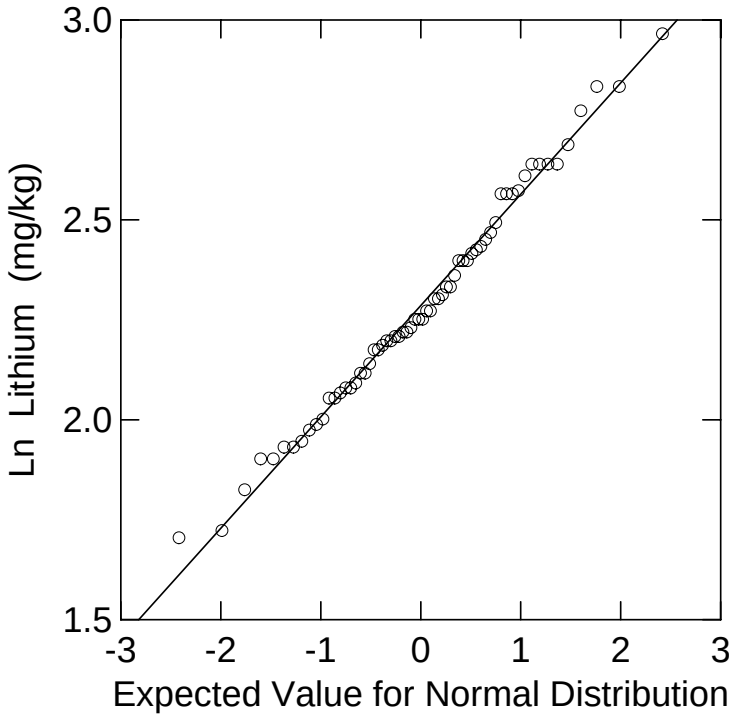


Figure A3.4.6 **Probability Plot for Lithium Concentrations (Natural Logarithm) in IDEU Surface Soil**

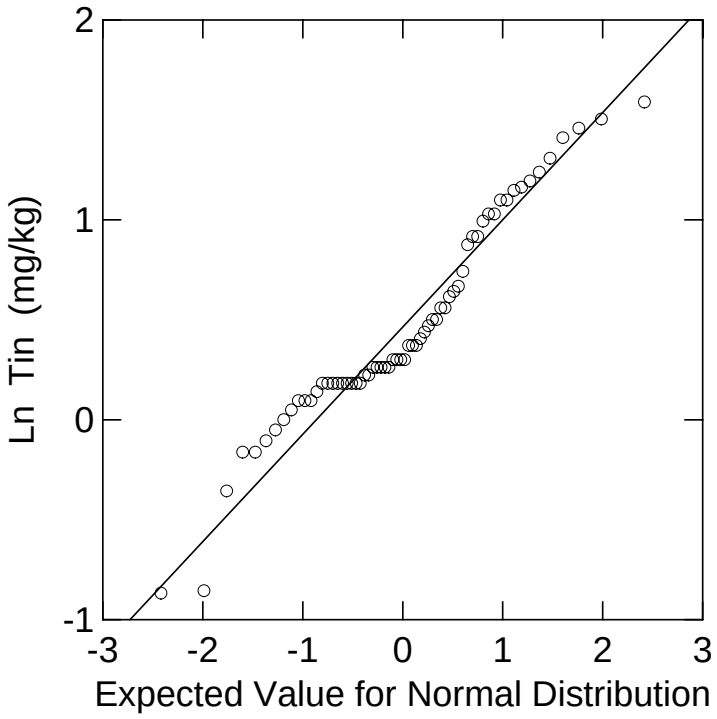


Figure A3.4.7 Probability Plot for Tin Concentrations (Natural Logarithm) in IDEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

INTER-DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 4

Risk Assessment Calculations

TABLE OF CONTENTS

1.0 ECOLOGICAL RISK ASSESSMENT TABLES

Table A4.1.1
Non-PMJM Intake Estimates for Antimony - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -3.233 + 0.938(lnCs)	1	BAFsm = ((0.5*BAFsp)+(0.5*BAFsi))*0.003*50)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
3.1	Tier 1 UTL	0.11	3.1	0.24	0.028	
1.9	Tier 1 UCL	0.07	1.9	0.15	0.017	
9.83	Tier 2 UTL	0.34	9.8	0.76	0.028	
6.18	Tier 2 UCL	0.22	6.2	0.48	0.017	
Intake Parameters						
	IR(food) (kg/kg BW day)	**IR(water) (kg/kg BW day)**	**IR(soil) (kg/kg BW day)**	**Pplant**	**Pinvert**	**Pmammal**
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.202	N/A	0.00403	0.00532	0.211
Tier 1 UCL	N/A	0.124	N/A	0.00247	0.00323	0.129
Tier 2 UTL	N/A	0.639	N/A	0.0128	0.00532	0.657
Tier 2 UCL	N/A	0.402	N/A	0.00803	0.00323	0.413

N/A = Not applicable.

Table A4.1.2
Non-PMJM Hazard Quotients for Antimony - Default Exposure Scenario

		TRV (mg/kg BW day)		Hazard Quotients	
	Total Intake (mg/kg BW day)	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Deer Mouse - Insectivore					
Tier 1 UTL	2.11E-01	6.00E-02	5.90E-01	**4**	0.4
Tier 1 UCL	1.29E-01	6.00E-02	5.90E-01	**2**	0.2
Tier 2 UTL	6.57E-01	6.00E-02	5.90E-01	**11**	1
Tier 2 UCL	4.13E-01	6.00E-02	5.90E-01	**7**	0.7

Table A4.1.3
Non-PMJM Intake Estimates for Lead - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -1.328 + 0.561 (ln Cs)	lnCi = -.218 + 0.807 (ln Cs)	lnCsm = 0.0761 + 0.4422 (ln Cs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
62.8	Tier 1 UTL	2.70	22.71	6.73	0.037	
42.7	Tier 1 UCL	2.18	16.64	5.68	0.022	
48.4	Tier 2 UTL	2.34	18.41	6.00	0.037	
37.6	Tier 2 UCL	2.03	15.01	5.37	0.022	
Intake Parameters						
	IR(food) (kg/kg BW day)	**IR(water) (kg/kg BW day)**	**IR(soil) (kg/kg BW day)**	**Pplant**	**Pinvert**	**Pmammal**
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	0.622	N/A	N/A	1.34	0.00444	1.97
Tier 1 UCL	0.501	N/A	N/A	0.913	0.00264	1.42
Tier 2 UTL	0.537	N/A	N/A	1.04	0.00444	1.58
Tier 2 UCL	0.466	N/A	N/A	0.804	0.00264	1.27
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	5.22	N/A	1.34	0.00444	6.57
Tier 1 UCL	N/A	3.83	N/A	0.913	0.00264	4.74
Tier 2 UTL	N/A	4.23	N/A	1.04	0.00444	5.27
Tier 2 UCL	N/A	3.45	N/A	0.804	0.00264	4.26

N/A = Not applicable.

Table A4.1.4
Non-PMJM Hazard Quotients for Lead - Default Exposure Scenario

		TRV (mg/kg BW day)		Hazard Quotients	
	Total Intake (mg/kg BW day)	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Mourning Dove - Herbivore					
Tier 1 UTL	1.97E+00	1.63E+00	1.94E+00	1	1
Tier 1 UCL	1.42E+00	1.63E+00	1.94E+00	0.9	0.7
Tier 2 UTL	1.58E+00	1.63E+00	1.94E+00	1	0.8
Tier 2 UCL	1.27E+00	1.63E+00	1.94E+00	0.8	0.7
Mourning Dove - Insectivore					
Tier 1 UTL	6.57E+00	1.63E+00	1.94E+00	**4**	**3**
Tier 1 UCL	4.74E+00	1.63E+00	1.94E+00	**3**	**2**
Tier 2 UTL	5.27E+00	1.63E+00	1.94E+00	**3**	**3**
Tier 2 UCL	4.26E+00	1.63E+00	1.94E+00	**3**	**2**

COMPREHENSIVE RISK ASSESSMENT

INTER-DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 5

Chemical-Specific Uncertainty Analysis

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BAF	bioaccumulation factor
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOPC	ecological contaminants of potential concern
EcoSSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
EU	Exposure Unit
HQ	hazard quotient
IDEU	Inter-Drainage Exposure Unit
LOAEL	lowest observed adverse effect level
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
TRV	toxicity reference value
UCL	upper confidence limit
UTL	upper tolerance limit

1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., Ctissue = BAF * Csoil), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternate exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the U.S. Environmental Protection Agency (EPA) ecological soil screening level (EcoSSL) guidance (EPA 2005).
- **Toxicity Reference Values (TRVs).** The Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005) utilized an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis in the following subsections. When an alternative TRV is identified, the chemical-specific subsections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.
- **Background Risks.** Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to help gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potential site-related risks. Background risks were calculated for detected analytes in surface soil in Appendix A, Volume 2, Attachment 9 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation – Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report).

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

1.1 Antimony

Bioaccumulation Factors

There is considerable uncertainty associated with the soil-to-invertebrate BAF for antimony. No soil-to-invertebrate BAF was identified in the CRA Methodology and, therefore, a default value of 1 was used as the BAF. As a result, all intake calculations assume that antimony concentrations in terrestrial invertebrate tissues are equal to concentrations in surface soils. Because antimony is not typically a bioaccumulative compound, this assumption is likely to overestimate antimony concentrations and subsequent risk estimations to an unknown degree.

Toxicity Reference Values

For mammalian receptors such as the deer mouse, review of the toxicity data provided in EPA (2003) indicates that only one bounded lowest observed adverse effect level (LOAEL), used in the risk estimation as the default LOAEL TRV, is lower than the geometric mean of growth and reproduction no observed adverse effect level (NOAEL) TRVs. All other bounded LOAEL TRVs for growth, reproduction, and mortality are more than an order of magnitude greater than the NOAEL and LOAEL used as the default TRVs. The default NOAEL and LOAEL TRVs for antimony are based on a decrease in rat progeny weight, and the effect of a predicted decrease in birth weight on the mammalian receptors in the Inter-Drainage Exposure Unit (EU) (IDEU) is unknown. Since the endpoint for the LOAEL TRV is based on an acceptable endpoint as defined by the CRA Methodology, the overall uncertainty related to the antimony TRVs should be considered to be low. However, the combination of a TRV endpoint of questionable applicability toward measuring the assessment endpoint and the review of the entire TRV database that indicated the LOAEL concentration is significantly lower than the remainder of the applicable effects-based TRVs reviewed by USEPA (2003) suggests that the uncertainties should be carefully considered in risk management decisions.

Background Risk Calculations

Antimony was not detected in background surface soils. Therefore, background risks were not calculated for antimony in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.2 Lead

Bioaccumulation Factors

For the soil-to-plant and soil-to-invertebrate BAFs, regression equations were used to estimate tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of lead to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for birds were obtained from EPA (2003). The EPA document reviewed the available effects database for avian effects from lead. The NOAEL TRV represents a dose of lead at which no growth, developmental, reproductive, or mortality effects were noted. The NOAEL TRV represents a dose rate at which no change in chicken reproduction was noted. The LOAEL TRV represents a dose rate at which a decrease in Japanese quail reproduction was noted, and the effect of a predicted decrease in reproduction on the avian receptors in the IDEU is unknown. A threshold TRV, representing an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur, was not calculated because the threshold point is uncertain and is impossible to accurately estimate given the available data. The default TRVs are based on appropriate endpoints and are of sufficient quality for use in the risk characterization. Uncertainties in these TRVs are likely to be low; however, risks may still be overestimate or underestimated to an unknown degree using these TRVs.

Background Risks

Lead was detected in Rocky Flats Environmental Technology Site (RFETS) background surface soils.

Risks to the mourning dove (herbivore and insectivore) were calculated in Appendix A, Volume 2, Attachment 9 of the RI/FS Report using both the upper confidence limit (UCL) and upper tolerance limit (UTL) of background soils. No HQs greater than 1 were calculated for the mourning dove (herbivore) using the NOAEL or LOAEL TRVs. NOAEL and LOAEL HQs for the mourning dove (insectivore) were greater than 1 for all UCL and UTL exposure point concentrations (EPCs). NOAEL HQs ranged from 4 (UTL EPC) to 3 (UCL EPC), whereas LOAEL HQs ranged from 3 (UTL EPC) to 2 (UCL EPC).

2.0 REFERENCES

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (EcoSSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (EcoSSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response. February.

COMPREHENSIVE RISK ASSESSMENT

INTER-DRAINAGE EXPOSURE UNIT

VOLUME 5: ATTACHMENT 6

CRA Analytical Data Set